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Software	Lactate Plus - CD incluido con el cable

Tiempo medición	10 segundos
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Summary / Sumario

Good Clinical Practice in the use of regenerative medicine in athletes

Buena práctica clínica en el uso de la medicina regenerativa en los deportistas

Javier Narbona Cárceles[1], María Eugenia Fernández Santos[2]

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As we all know, over the past decade there has been an authentic boom in the use of cellular therapies and products such as Plasma Rich in Growth Factors and its various meanings (hereinafter PRP). The ease of collecting techniques as well as the apparent "harmlessness" or the feeling that they are low-risk techniques has led to a significant increase in the use of these products in fields such as Sports Medicine. Yet it should be considered that just as there is clear legislation regarding the regulation of the use of medicines, surgical treatments and transplants, treatment with biological products (cellular therapy and PRP) is also subject to a legal framework, regarding which unfortunately many professionals are not fully informed or aware. In the case of PRP, as it is a product obtained using lab-based manipulation, it is considered a consolidated medicine (different, for example, to a blood transfusion), and therefore it should be applied in accordance with the usage regulation established by the Spanish Medicine Agency (AEMPS) and the authorities in each Spanish autonomous community[1]. In the case of the different cell types, which are not yet consolidated treatments, the previous authorisation of the Spanish Medicine Agency (AEMPS) should be applied under the provisions of a clinical trial or with compassionate or special uses. In the event that we are unsure whether our product is considered a medicine or not, we should always consult the experts from the Agency, who will provide the answer. However, in many cases clinicians wish to use this type of medicine under their own responsibility and risk - generally under the provisions of information offered by laboratories regarding their products. These include: "quick and easy access to the product means it is not considered a medicine", "it is made in a closed system and does not require authorisation", etc. added to the long list of pathologies that can be treated with these products. These are false concepts that lead to a poor use of these therapies.

When considering the development of this editorial we had the idea of focusing on Good Clinical Practices (GCP) regarding the application of regenerative medicinal products on our athletes, but it is clear that no professionals doubt their ethics and their good clinical criteria in this type of application, and that perhaps the problem lies in the lack of knowledge that many of us have when it comes to discriminating between the different products to which we have access, the legal considerations that are required of each one, as well as how to know which is the most suitable product for treating pathologies. Therefore we have decided to summarise how we define each product.

Cellular types in research used in traumatology/sports medicine

The gold standard tissue used in the field of traumatology for usage in regenerative medicine is bone marrow (BM), mainly collected from the iliac crest. From this, we can obtain various cell types with special characteristics in terms of their capacity to divide and differentiate into tissues that are different from their origin, depending on the microenvironment that surrounds them.

In sports medicine and traumatology, bone marrow is generally collected with the aim of using the mesenchymal stem cells (stem cells) present within it. But it should be considered that they are in a very low concentration. By spinning the sample using methods such as the

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density gradient (Ficoll), we get the part of the bone marrow comprising mononuclear cells, eliminating the plasma, erythrocytes and platelets. These cells include macrophages, lymphocytes, megakaryocytes and haematopoietic progenitor cells, among others. From the whole of this cell group obtained, approximately just 1 from every 1,000/100,000 cells are the much desired mesenchymal cells. If we perform a "bone marrow concentration" (technique very widely used by diverse laboratories and trading houses), we would only be obtaining a concentrated product with a high number of heterogeneous cells, of which very few would actually be mesenchymal cells. From this, if we truly want to obtain mesenchymal cells, we should purify the sample, eliminating the rest of the unwanted cells. To do this, isolation techniques are applied based on the almost exclusive property of mesenchymal cells of adhering to plastic. The cells are cultivated for a specific length of time, and thanks to this property the unwanted cells are eliminated, eventually resulting in the homogeneous sample composed of mesenchymal cells. As a final stage, we should check that these cells meet two more requisites in order to confirm that they are mesenchymal cells, which are: positive phenotype for the markers (≥95%) CD105, CD73 and CD90, and simultaneously negative for (≤ 2%) for CD45, CD34, CD14 or CD11b, CD79a or CD19 and HLA-DR; and reveal a capacity to differentiate from osteoblasts, chondroblasts and adipocytes[2].

Only once we have obtained these cells through cultivation, are they considered to be true mesenchymal cells, and if they are not obtained without cultivation it is a group of cells among which there is a very small number of mesenchymal cells, but we can never say that this cell product comprises mesenchymal cells. For example, if we use a bone marrow concentrate (only collected using aspiration and spinning) to treat an avascular necrosis of the femoral head , we cannot say that we are applying mesenchymal cells.

These cells are the most used cells in traumatology, and we can find various publications in national and international research regarding their clinical use, in pathologies such as osteoarthritis in the knee[3-4] and pseudoarthrosis[5]. We should take into account that even with these publications available, the use of mesenchymal cells is still not considered to be consolidated treatment, i.e. their effectiveness is not considered to be proven so their usage should come under the provision of clinical trials, special or compassionate use, and therefore always with the authorisation of the AEMPS.

Another of the tissues used as a cell source is fatty tissue, obtained from liposuctions. With this tissue, after enzymatic digestion, we achieve a cell product called Stromal Vascular Fraction (SVF), which we could compare to mononuclear cells obtained from BM in terms of the heterogeneity of cell types that make up this product. Among these we can find haematopoietic cells, very small fractions of endothelial progenitors, of mesenchymal cells, etc. a product used for example in clinical trials for cardiac regeneration[6] and currently applied by many of our colleagues on patients with a wide range of pathologies in our field, without having, in the majority of cases, scientific proof of the efficiency of these treatments; and more importantly, used as conventional treatment when they are not yet consolidated products nor are they authorised by the AEMPS for their clinical use. For this we are safeguarded, mostly, in that in order to collect them we use closed systems and minimum manipulation, and that these cells are going to have the same purpose as their original tissue, etc. However, we should not forget that in all of these cases it should be the AEMPS that, following consultation, clarifies if the desired product to be used in each case is or is not a medicine, and therefore should comply with the applicable legislation for its use[7].

Just as we have previously explained with the BM, if we put SVF cells in cultivation, given their adhesion to the plastic, we get mesenchymal cells derived from fat, also used in bone regeneration but to a lesser extent. These cells present similar characteristics to those obtained from BM.

The use of rich plasma in growth factors (PRP)

PRP is one of the most used and demanded products in our clinical practice[8,9]. We will not go into more depth here describing PRP, which is widely known by all. We are going to focus on unscientific yet hugely relevant aspects.

As you can see, the PRP has been given a special treatment as it is not an advanced therapy product, the cells are not stem cells. This is a frequently seen news headline every time one of our colleagues applies it to an athlete, with the damage this does to the good use of the medicine. Responsibility for the poor information that is transmitted to the public in general when "to sell more" we give out this kind of information is ours and only ours. Not only when it is released in the press, but also when we are capable of marketing the product as if it were a "magic potion", able to "cure" all kinds of illnesses and which can be applied whenever necessary. The majority of times without much scientific evidence. We should be clear that as it is a medicine, this type of publicity is not allowed. Our obligation as professionals is to comply rigorously with the existing legislation, the base of the Good Clinical Practices that should define professionals in the clinical practice in general.

Another important aspect to consider with our patients is their follow up. Every time that we treat a patient with advanced therapy products or with PRP-type medicines, we should receive help from experts in all the currently applied fields to understand the cases in which its use is recommended[10], and to perform a careful follow up of them. Likewise, in the case of treatment that is classified as medicine, we should notify the pharmacovigilance centres in each autonomous community at the very first suspicions of any adverse reactions. More information about how to do this can be found on the AEMPS website: http://www.aemps.gob.es/vigilancia/medicamentosUsoHumano/home.htm.

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Biochemical changes in Popular Runners after a marathon (Stress Test)

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Summary

The study we conducted with a group of veteran runners, but with a long career in the popular sport, is to analyze the changes that occur in biochemical profiles of a group of fifteen amateur runners who run a marathon. This maximum effort we have called "stress tests".
Our goals are aimed at evaluating the results of the changes in biochemical parameters in simple popular runners to reference them with those occurring in professional athletes, is a prevalence study without previous variables or random assignment.
The method employed: previous blood sampling (baseline or reference conditions) and another immediately after.
The results: increased blood glucose concentration of 3.25% increased 95% urea and creatinine of 45.3 while on cholesterol has no effect on triglycerides and the increase was 3%.
We discuss our results against the results published on the professionals, with the intent to see the differences in the changes of biochemical values in the pros versus popular riders, amateurs and veterans. We found studies professionals from other disciplines, such as triathletes, cyclists, skiers etc.
The conclusion is that the benefits and harms of intense physical exercise are as beneficial or detrimental to both groups. But the differences in biochemical values are used to compare the professional and amateur sport.

Key words:
Sports stress.
Glucose & marathon.
Urea-creatinine & carathon.
Cholesterol-triglycerides & marathon.

Cambios bioquímicos en corredores populares tras correr una maratón (test de estrés)

Resumen

El estudio que hemos llevado a cabo con un grupo de corredores veteranos, pero con una larga trayectoria en el deporte popular, consiste en analizar los cambios que se producen en los perfiles bioquímicos de un grupo de quince corredores populares que corren una maratón. A este esfuerzo máximo lo hemos denominado "Test de Estrés".
Nuestros objetivos se encaminan a evaluar los resultados de los cambios producidos en los parámetros bioquímicos simples en corredores populares para referenciarlos con los que se producen en los atletas profesionales, es un estudio de prevalencia, sin variables previas ni asignación aleatoria.
El método empleado: toma de muestra sanguínea previa (condiciones basales ó de referencia) y otra inmediatamente posterior.
Los resultados obtenidos: incremento de la concentración de glucemia en sangre del 3,25% incremento de la urea del 95% y de la creatinina del 45,3 mientras sobre el colesterol no tiene repercusión y sobre los triglicéridos el incremento esta en 3%.
Discutimos nuestros resultados comparándolos con los resultados publicados sobre los profesionales, con la intención de ver las diferencias en los cambios de los valores bioquímicos en los profesionales frente a los corredores populares, aficionados y veteranos. Hemos encontrado estudios sobre profesionales de otras disciplinas, tales como triatletas, ciclistas, esquiadores etc.
La conclusión es que los beneficios y perjuicios de ejercicio físico intenso son tan beneficiosos o perjudiciales para ambos grupos. Pero las diferencias encontradas en los valores bioquímicos sirven para comparar el deporte profesional y aficionado.

Palabras clave:
Estrés deportivo.
Glucemia & maratón.
Urea-creatinina & maratón.
Colesterol-triglicéridos & maratón.

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Introduction

Humans are surprisingly good distance runners; in the entire animal kingdom there are very few mammals that can keep up a constant pace when running 10 Km or more (a marathon comprises 42,195m). Many animals are better sprinters than humans over short distances, such as leopards, but only very few land mammals and humans are capable of making long journeys at a jogging pace, and considering that humans only have two legs, they compete surprisingly well, weight for weight.

A surprising fact is that no primates are able to perform a resistance run. This distinct human capacity was the subject of an article in the Nature magazine on 18th November 2004 Bramble DM, *et al*.[1,2].

Therefore, anthropologically and medically speaking it is interesting to obtain as much information as possible regarding the physiology of the exertion as there are biochemical indicators regarding the efficiency of the physical exercise performed by people that partake in this physical expenditure in the prevention or correction of possible excesses, Nuviala-Mateo RJ, *et al*.[3,4]. There are many studies about marathon runners or athletes that undergo great exertion over long periods of time; but almost all of them refer to professional athletes Moreno-Lemos SM[5].

The marathon has special characteristics within the concept of the run: it is a running trial measuring 42,195 metres in a circuit not in a stadium, meaning it takes on the concepts of both a popular run and an athletic event. The completion time for professionals is less than 2 hrs 30 mins, whilst our study group times ranged between 3hrs 30 mins and 4 hrs 30 mins.

In order to complete the run in those times, the dedication of each participant is different: whilst professional athletes undergo scientific preparation, supervised by trainers, doctors, nutritionists and exertion physiologists, the only activity our group performed was to maintain a jogging pace, which they had been practising for over 10 years, with the only exception being that 60-90 days before the competition, they increased their dedication time, in which they increased their average of 60-90 minutes for 5 or 6 days a week, to 120 to 160 minutes five days a week, plus 1 day which was over 180 minutes.

It would appear that publishing our results would be interesting, considering that this is a group of male veteran runners of working age and who are not professionals, rather they participate in running races as a hobby.

The importance of using biochemical measurements as a way of monitoring the effect of training on individuals that partake in this sport is studied and published in scientific literature, as revealed in studies such as those by Moreno-Lemos SM, *et al*.[5,6].

With regards to the biochemical parameters studied, we only found discrepancies in terms of the behaviour of the blood glucose after strenuous exertion. Authors such as Bluche PF, *et al*.[7] propose an increase in blood glucose after the exertion. On the other hand, some authors, such as Minuk HL, *et al*.[8], propose that exertion brings about a drop in blood glucose immediately after the exertion.

We suggest the need to see the results obtained from our study group, in order to be able to compare them with results published about professional or semi professional athletes, and to confirm or oppose the results published. Studies about strenuous sports such as Triathlons have been published by authors such as Long D, *et al*.[9-11] and the results are similar to those collected in this study.

Material and methods

General protocol

A short time before the stress test (marathon), blood samples were taken from the group participants to establish the parameters that we were going to study after a 10-hour fasting period; and immediately after the run another blood sample was taken for the same purpose. The samples were identified, coded and kept chilled for transporting to the laboratory to determine the haematological parameters that are described in the study.

Once the results were collected in the laboratory, they were tabulated and studied with the aim of achieving statistical data that would allow us to produce graphs, informing us about the trend or behaviours of the blood parameters of the study subjects.

Material

The materials needed for the research were the essential tools for extraction (tourniquet, 10 cc syringes and 25/8 needles and the tubes where the samples would be deposited and identified. They were transported in a chilled environment (±4 º) until they reached the biochemical analysers. Later, once the results were gathered, we applied the data to register the information and then proceeded to tabulate it and produce graphs.

The sources of information (bibliographic references) that we used in this study were those gathered from different databases.

The group of people ("Los Chiribitos") had the following characteristics:

- A group of fifteen amateur runners that formed the Los Chiribitos running club. All 15 are males, with an average age of 50.4 years (±9.6-7.6).
- Anthropometric profile: average weight 76 ± 8 kg, an average height of 173± 8 cm, and a BMI of 2.5 ± 04.
- The time spent in preparatory training: over 90 days with road running training sessions lasting 1 to 1.5 hours six days a week.
- Average time as an amateur runner that can be considered to be an adaptation period: over 10 years.
- Time taken running (marathon): between 3 hrs 30 mins and 4 hrs 30 mins.
- Nutrition: the normal, local diet, no special diet.
- Medicines and supplements: Not mentioned (¿).
- Lifestyle: healthy (none smokers, moderate alcohol consumption, no drugs).
- Antecedents: no illnesses, various accidents or injuries, no lasting effects.
- Employment: varied.

Method

First, the participants underwent a health examination (including ECG to check their health and to reject unfit individuals). They received a talk beforehand in which the study was explained to them, and once they understood they gave consent for the study and for the data obtained to be published, whilst remaining anonymous, in the event that is should be of interest to the scientific community.

Results

Once the results obtained in our study were processed on the computer, they were transferred to graphs and were tabulated. These results were structured according to the different parameters studied, assessed before and after the "stress test", observing and studying the concentrations of blood glucose, urea, creatinine, total cholesterol and triglycerides.

Blood glucose

Starting with an average pre-test value of 80.00 mg/dl, the average value obtained after the test is 82.60 mg/dl, revealing an increase of the average values of 2.60 units, in absolute value, meaning the increase percentage is 3.25%.

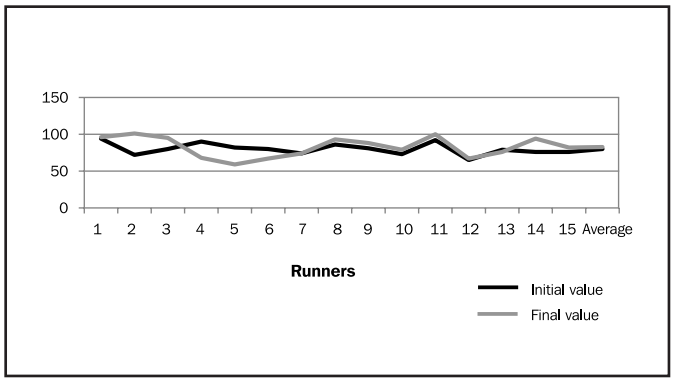
The pre-test blood glucose concentration values are all within the normal range, and regarding the average value, they oscillate between ±7-14. In the values obtained after the test, only two are over 100 mg/dl, but they are all within the normal ranges and oscillate between ± 18.4 -23.6. Therefore it can be observed that the dispersion of the values obtained after the test are framed within a wider range - yet within normality - than the dispersion obtained in the pre-test study values (Table 1, Figure 1).

Table 1. Blood glucose levels in mg/dl.

I.D.	Prior	Post
1	94	96
2	72	101
3	80	95
4	90	68
5	82	59
6	80	67
7	74	74
8	86	93
9	81	88
10	73	79
11	92	100
12	65	67
13	79	76
14	76	94
15	76	82
Average	8000	82.60

I.D: Subjects. Prior: initial values.
Post: final values. Average: arithmetic average.

Figure 1. Blood glucose levels.



Urea

Starting with an average value of 32.8 mg/dl in the pre-test measurements, after the test an average value is achieved of 64.20 mg/dl, meaning that the values increase by 31.34 units, which as a percentage reaches 95.54%.

Both the values of urea concentration in the blood in the pre and post test measurements have values below 100 mg/dl, and limited with the average values, it can be seen that the pre-test values are in a dispersion window in a range of ± 4.2-5.8 whilst dispersion in the post-test measurements ranges at ± 15.5-18.8. This leads us to observe that the dispersion of the values obtained before and after the test move in quite similar ranges and the only outstanding aspect is the huge increase shown in the post-test measurements (Table 2, Figure 2).

Table 2. Uremia levels in mg/dl.

I.D.	Prior	Post
1	33	46
2	37	50
3	37	62
4	37	60
5	35	75
6	26	60
7	27	75
8	32	56
9	38	73
10	37	60
11	27	62
12	26	64
13	33	75
14	37	65
15	30	80
Average	32.80	64.20

I.D: Subjects. Prior: initial values.
Post: final values. Average: arithmetic average.

Figure 2. Uremia levels.

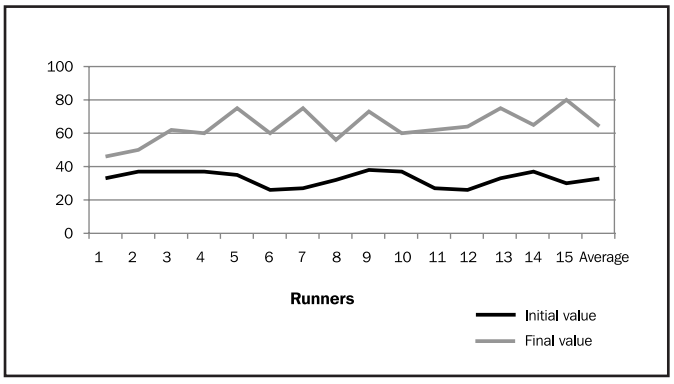
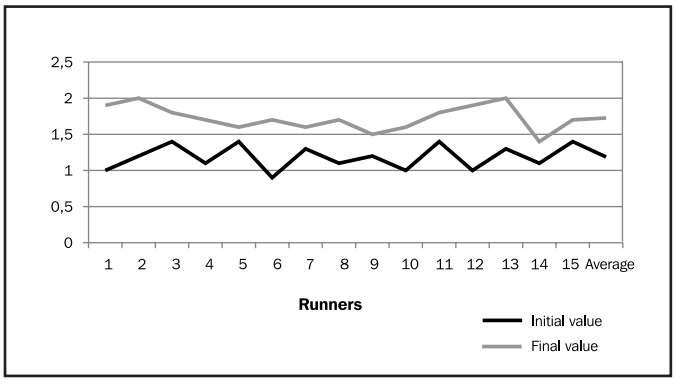


Figure 3. Creatinine levels.



Creatinine

Starting with an average value of 1.19 mg/dl in the pre-test measurements, in the post-test the average value reaches 1.73 mg/dl, revealing an increase of 0.54 units in the average value, giving a percentage of 45.37%.

The values established in the pre-test measurements fall within the normal range (>1.3), which means that 26.6% are above the average. Whilst in the post-test measurements, 100% are above the normal range.

The dispersion window of the pre-test values is within the range of ± 021-0.29 whilst the dispersion of the values found in the post-test measurements falls within a range of ± 0.27-0.33. Thus by observing the previous data, it can be seen that the behaviour of the creatinine is quite similar to that of urea in the test: the difference lies in the percentage increases and in the dispersion ranges (Table 3, Figure 3).

Total cholesterol

The average value of the pre-test measurements is 175.40 mg/dl, and after the test the average value of the measurements reaches a figure of 174.47 mg/dl, revealing a decrease of 0.93 units, which is a percentage of 0.53%.

Both the pre and post test values are within the normal range for this kind of demographic (<200). The pre-test values fall within a range of ± 16.6-25.4, whilst the values obtained after the test fall within the range of ± 16.53-14.47 (Table 4, Figure 4).

Triglycerides

The data obtained reflects a behaviour very similar to the total Cholesterol, i.e. we start with a pre-test average value of 80.33 mg/dl

Table 3. Creatinine levels in mg/dl.

I.D.	Prior	Post
1	1	1.9
2	1.2	2
3	1.4	1.8
4	1.1	1.7
5	1.4	1.6
6	0.9	1.7
7	1.3	1.6
8	1.1	1.7
9	1.2	1.5
10	1	1.6
11	1.4	1.8
12	1	1.9
13	1.3	2
14	1.1	1.4
15	1.4	1.7
Average	1.19	1.73

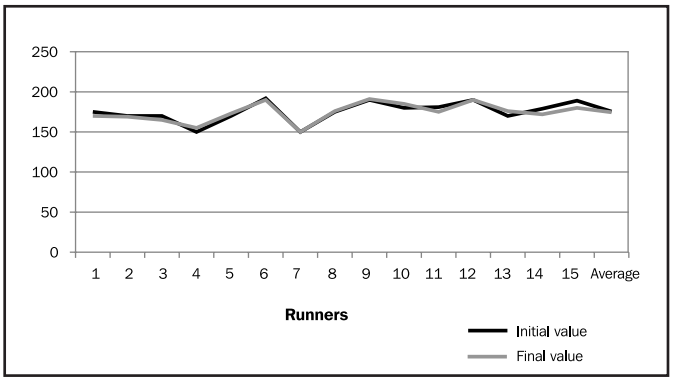
I.D: Subjects. Prior: initial values.
Post: final values. Average: arithmetic average.

Table 4. Cholesterol levels in mg/dl.

I.D.	Prior	Post
1	175	170
2	170	169
3	170	165
4	150	155
5	170	173
6	192	190
7	150	150
8	175	176
9	190	191
10	180	185
11	181	175
12	190	190
13	170	176
14	179	172
15	189	180
Average	175.40	174.47

I.D: Subjects. Prior: initial values.
Post: final values. Average: arithmetic average.

Figure 4. Cholesterol levels.



and the post-test average value is 82.67 mg/dl, producing an increase of 2.34 units, which is a percentage of 2.91%.

If we consider normal blood Triglyceride values to be lower than 150 mg/dl, we can see that all the measurements, both pre and post test, produce values that are lower than 100 mg/dl, i.e. within normal range, and we can also observe that the range of distribution in the pre-test measurements falls within ± 14.67-10.33 whilst in the post-test this range is in ± 13.33-7.67 (Table 5, Figure 5).

Discussion

Once the results of our study are obtained and processed on the computer, we obtain some tables and graphs to compare them with those obtained by other authors.

By limiting the values obtained in our study with those obtained by other authors, we should consider the diversity of the study groups, as the studies we have found in literature refer to professional athletes, and despite the dedication of our study group to the sport being high, they cannot be considered to be professional athletes.

With regards to the behaviour of blood glucose under strenuous exertion, some suggest an increase after exertion, Bluche PF, *et al.*[7], whilst others propose a reduction with the same exertion Minuk HL, *et al.*[8]. According to our data, an increase of 3.25% occurs in the average values.

We consider this increase to be down to two independent yet related factors: on the one hand, dehydration must be considered when strenuous exertion is performed; and on the other hand, the release of catecholamines and neurotransmitters should be taken into account, which cause the stress of the exertion and this in itself causes hyperglycaemia. Therefore we align with Bluche PF, *et al.*[7] and with those that describe hyperglycaemia with exertion Bluche PF, *et al*[7,9,10].

Other authors study the effects of the marathon on people with diabetes, and make recommendations regarding when they should participate and when they should refrain, as well as recommendations for controlling diabetes during a marathon Graveling AJ, *et al.*[11-13].

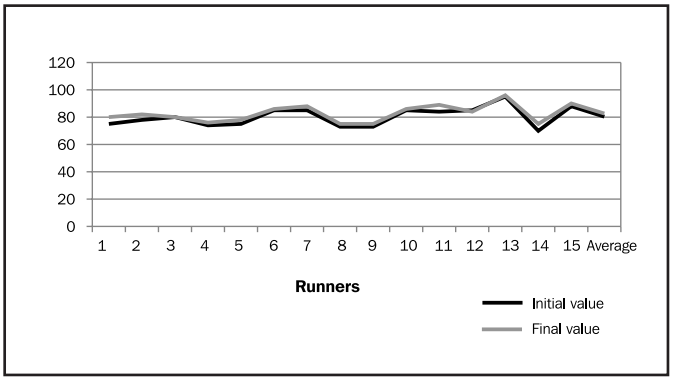
When observing the behaviour of urea in marathon runners, we agree with Zapico, *et al.*[13-15] who found important increases in urea levels after strenuous exercise Murillo S, *et al.*[14-15]. Our data - raised average

Table 5. Triglyceride levels in mg/dl.

I.D.	Prior	Post
1	75	80
2	78	82
3	80	80
4	74	76
5	75	78
6	85	86
7	85	88
8	73	75
9	73	75
10	85	86
11	84	89
12	85	84
13	95	96
14	70	75
15	88	90
Average	80.33	82.67

I.D: Subjects. Prior: initial values.
Post: final values. Average: arithmetic average.

Figure 5. Triglyceride levels.



values of 95.5% - do not coincide in magnitude with data from these studies, but the trend is the same, which we justify with the fact they are not homogeneous groups or similar sports. Our explanation of this 95.5% increase of the average values is not unique. We believe that it is due to dehydration, a product of exertion, and that the participants do not correctly replenish these liquids during the exertion period. On the other hand, we put this considerable increase down to the metabolism of the tissues, fundamentally the striated muscle, which occurs with extreme exercise.

From observing the data regarding creatinine, similar behaviour can be observed to that of urea in terms of the trend in the post-exertion test. This is described by authors such as Zapico AG, *et al.*[13-15]. The only difference in the behaviour of the urea and the creatinine is the magnitude of the increase, which for the urea is 95.5%, whilst for the creatinine it is 45.3%. We give this relative value, as in order for it to

be significantly important there should have been a series of samples taken over a period of time afterwards, whilst our study merely reflects a "photo finish" after the marathon. The explanation behind the increase is the same that we offer to explain the increase in the urea.

The studies by Mydlik M, *et al.*[16,17] compare the conditions of the urine excretory tract with its behaviour within the symptoms of kidney failure.

The behaviour of total cholesterol and the triglycerides after the exertion - in this case a marathon - proves to be irrelevant in the findings of our study. We discovered a 0.53% increase in the average values for cholesterol, which reveals practically no variation, and 2.91% for the triglycerides, which is also minimal.

All of our data has been compared with that from various authors that have studied the same issue - Warburton DER, *et al.*[18-20] - and we all reach the same assumptions.

The results obtained from our study were compared with those from different authors that have assessed similar parameters and published in various media - Coggan A, *et al.*[21-23] - and with those previously mentioned in this work. We were able to reach a conclusion from the results in our research and express them.

We observed the behaviour of the biochemical parameters studied both before and after the study group underwent the maximum exertion.

As mentioned previously, the study group is a homogeneous group of adult males of working age (average age 50.4 years with a deviation of ±7.6-9.6), that have been participating in significant physical activity for a considerable amount of time, meaning that the conditioning phase has been exceeded.

Therefore, after the discussion phase and comparing data published by other researchers, we believe that this is interesting data regarding the changes in the biochemical parameters analysed after executing a maximum exertion, stress test.

Conclusions

After the explanatory phase of the results obtained in our study, to see the agreement or discrepancy with those obtained by other authors, we conclude that:

- Blood glucose rises after the stress test by 3.25% and we deduce that this is due to a double mechanism: dehydration caused by the exertion along with the failure to replenish lost liquids and nutrients correctly.
- The other cause, for us, behind the raised blood glucose, is the significant release of catecholamines that act as hyperglucemiants.
- We consider that both the urea and the creatinine have a similar behavioural profile, which is a considerable increase after the stress test; this increase is 95.5% for the urea and 45.3% for the creatinine. We explain this increase with dehydration and the excessive increase of tissue metabolism, caused by the exertion, especially the large amount of striated muscle tissue that is used in the exertion.
- We have observed that the behaviour of the total cholesterol and triglycerides retains a similar profile and the only point we can gather is that the variations are so minimal that we can conclude they are not significant.

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Anthropometric profile, physical fitness and differences between performance level of Parkour practitioners

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Summary

Introduction: The aims of this study were to determinate the anthropometric profile and physical fitness of Parkour practitioners and to establish differences by performance level.
Method: Thirteen Parkour practitioners participated on this study. Agility, hamstring extensibility, horizontal jump distance, vertical jump height, vertical jump power, estimation of maximal oxygen consumption, body composition and somatotype were assessed with a battery of six tests. Also, a specific test which simulated a competition situation was performed in order to establish two groups (A: high performance; B: low performance) by the obtained score.
Results: Groups A and B obtained respectively 1.7-5.3-2.5 and 2.2-4.2-2.8 on somatotype; 7.50 ± 0.52 and 8.67 ± 2.13% on fat mass; 47.44 ± 2.03 and 45.91 ± 2.68% on skeletal muscle mass; 12.47 ± 0.70 and 12.53 ± 1.21% on bone mass; 72.80 ± 11.01 and 55.19 ± 6.06 ml•Kg^{-1}•min^{-1} on estimated oxygen consumption; 14.36 ± 0.47 and 15.29 ± 0.44 s on Illinois test (agility); 13.77 ± 5.20 and 7.86 ± 12.70 cm on sit and reach test; 50.09 ± 3.47 and 37.19 ± 4.82 cm on vertical jump height; 2820.84 ± 453.72 and 2105.84 ± 237.24 W on vertical jump power and 2.97 ± 0.71 and 2.60 ± 0.22 m on horizontal jump distance. Group A obtained significant lower values on ectomorphy and higher on mesomorphy, estimated oxygen consumption, agility, horizontal jump distance and vertical jump height and power.
Conclusions: After determining anthropometrical profile and physical fitness, we observe that vertical jump seems to be the most important parameter on Parkour performance, also other variables like estimated maximal oxygen consumption, agility, vertical jump power, horizontal jump distance, mesomorphy and ectomorphy appear as possibly determinant factors on Parkour performance.

Palabras clave:
Parkour. Performance. Anthropometry.

Perfil antropométrico, condición física y diferencias por nivel de rendimiento en practicantes de Parkour

Resumen

Introducción: Los objetivos del presente estudio fueron determinar el perfil antropométrico y condición física de los practicantes de Parkour y establecer diferencias en función del nivel de rendimiento.
Método: Trece practicantes de Parkour participaron en este estudio. Se valoró la agilidad, extensibilidad isquiosural, distancia de salto horizontal, altura de salto vertical, potencia de salto vertical, estimación del consumo de oxígeno máximo, composición corporal y somatotipo con un batería de seis test. Se llevó a cabo, además, un test específico que simulaba una situación de competición para establecer los dos grupos (A: mayor rendimiento; B: menor rendimiento) en función de los resultados obtenidos.
Resultados: Los grupos A y B obtuvieron, respectivamente, un somatotipo de 1,7-5,3-2,5 y 2,2-4,2-2,8; 7,50 ± 0,52 y 8,67 ± 2,13% en porcentaje de masa grasa; 47,44 ± 2,03 y 45,91 ± 2,68% en masa muscular esquelética; 12,47 ± 0,70 y 12,53 ± 1,21% en masa ósea; 72,80 ± 11,01 y 55,19 ± 6,06 ml•Kg^{-1}•min^{-1} en consumo máximo de oxígeno estimado; 14,36 ± 0,47 y 15,29 ± 0,44 s en el test de Illinois (agilidad); 13,77 ± 5,20 y 7,86 ± 12,70 cm en sit and reach; 50,09 ± 3,47 y 37,19 ± 4,82 cm en altura de salto vertical; 2.820,84 ± 453,72 y 2.105,84 ± 237,24 W en potencia de salto vertical y 2,97 ± 0,71 y 2,60 ± 0,22 m en distancia de salto horizontal. Comparando ambos grupos, el A obtuvo valores significativamente inferiores en ectomorfia y superiores en mesomorfia, estimación del consumo máximo de oxígeno, agilidad, distancia de salto horizontal, potencia y altura de salto vertical.
Conclusiones: Tras determinar el perfil antropométrico y condición física, observamos que el salto vertical se presentó como el parámetro más importante en el rendimiento en Parkour, además de otras variables como el consumo máximo de oxígeno, la potencia de salto vertical, la distancia de salto horizontal, la mesomorfia y la ectomorfia.

Key words:
Parkour. Rendimiento. Antropometría.

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Introduction

Parkour has been defined as an extreme recreational activity in which a practitioner (traceur) reaches obstacles in the fastest and most efficient way possible, where it intervenes runs, jumps, vaults and climbing[1]. As Thibault & Roberts[2] indicate, there is a lot of controversy on Parkour definition. The word Parkour comes from the French word "parcours", which means route and it appeared in France in the 80's decade.

Research on Parkour is not as developed as other sportive activities. Previous studies have reported injuries produced on the practice[3-8]. Later, other studies with a sociological objective are focused on Parkour, studying how the -traceur- is involved on the environment, liberation of homogenization and globalization[9], the bad conception of this activity in society[10]. Other authors analysed the relationship of narcissist behavior and leadership among young people who practice risk sports, specially Parkour[11,12] and interviews for defining experiences[13].

Otherwise Leite *et al*.[14] determined physical fitness of Parkour practitioners in thirteen male traceurs, measuring performance variables such as aerobic capacity, vertical and horizontal jumps, hamstrings extensibility among others, concluding that Parkour improves upper limb more than lower limb and that its practice does not seem to need high values on physical fitness. Other authors have designed specific training sessions for this activity, focusing on the strenght-resistance development[15]. Grosprêtre & Lepers[16] compared Parkour practitioners with gymnast and power athletes, pointing out that traceurs have high plyometric abilities, great upper-to-lower limb coordination, high long jump, high vertical jump performance or knee extensors strenght. Puddle & Maulder[17] demonstrated that Parkour technique for landing gets lower ground reaction forces than traditional sports landing techniques.

Some authors also have treated the topic of incursion of Parkour in Physical Education classes[18], and Soto *et al*.[19] affirmed that children who practiced Parkour in Physical Education classes, avoided low motor coordination, which can carry to a lower adherence to sportiest practice, being Parkour an useful way to contribute to the improvement of coordination in childhood.

The aims of the present study were to determinate anthropometric profile and physical fitness of Parkour practitioners and to establish the differences between different performance groups in order to determine Parkour performance factors.

Material and method

Thirteen traceurs participated in this study. They were informed about the aims and procedures of the study and signed an informed consentient before starting the data collection. Inclusion criteria that traceurs had to achieve were: at least 3 years on Parkour practice, be older than 18 years old, not having any injury during data collection and not to practice any other kind of sport habitually (Table 1).

Measurements were done in three not consecutive days. Anthropometric data was collected on the first day, physical fitness test were done on the second day and the third day was for dividing the group by performance levels.

Table 1. General characteristics of the traceurs.

N	Age (years)	Stretch stature (cm)	Body mass (Kg)	Experience (years)
13	21.16 ± 2.52	177.25 ± 6.42	70.55 ± 9.06	5.57±2.34

Twenty anthropometric measurements were performed following the guidelines proposed by the *International Society for the Advancement of Kinanthropometry* (ISAK)[20].

Body mass and stretch stature were measured with a balance with stadiometer Seca 720 (Hamburg, Germany) with a precision of 100 g and 1mm. A total of 8 skinfolds (triceps, biceps, subscapular, iliac crest, Supraspinale, abdominal, front thigh and medial calf) with a Holtain® skinfold caliper (Holtain Ltd, Crymych, United Kingdom) with 0.2 mm of precision; 6 girths (arm relaxed, arm flexed and tensed, waist, gluteal, mid thigh and calf) with an anthropometric tape Cescorf® (Cescorf Ltda., Brasil) with a precision of 1 mm, and 4 breadths (biepicondylar humerus and femur, bistyloid and bimaleolar) with a modified Vernier caliper with 0.5 mm of precision.

All measures were taken twice and on the right side of the participants, the two measurements were compared with a tolerance of 5% for skinfolds and 1% for girths, breadths, body mass and height. In the case of a tolerance overcome, a third measurement was taken.

Dependent variables calculated using the anthropometric measurements were somatotype, using the Heath-Carter method[21], skeletal muscle mass through the Lee[22] formula, bone mass through Martin[23] formula and Yuhasz[24] formula for fat mass.

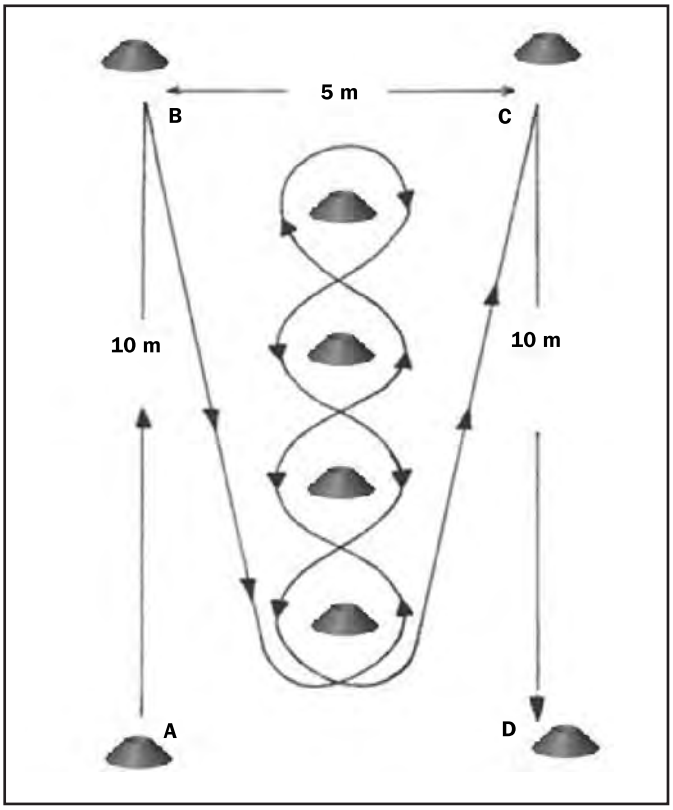
For the estimation of maximal oxygen consumption, it was used the 20 m shuttle run test[25].

Twenty meters shuttle run test consisted on running continuously between two point that were 20 m apart from side to side. These runs are synchronized with a pre-recorded audio tape. As the test proceeds, the athletes have to increase their speed over the course of the test until it is impossible to keep in sync with the recording. Initial speed is set on 8 $Km \cdot h^{-1}$, increasing to 9 $Km \cdot h^{-1}$ the first minute, then it increased a half kilometer per hour each minute. It was performed only one try per athlete.

For testing agility, we used the Illinois test, which consisted on running in a circuit with 10 x 5 m as area. Four cones in the corner and other four cones on the middle of the rectangle were used. The cone A marks the beginning of the test, B and C the turning points, and D as the end of the test. Athletes had to touch with one of their hands cones B and C, the end of the test was when they crossed the cone D. The circuit is presented in Figure 1. All athletes performed 2 attempts, saving the best score for each athlete.

Sit & reach test was used for the measurement of hamstring extensibility, having every athlete 3 attempts. They sat with their feet against the testing box and their knees extended. Then they placed the right hand over the left hand and reached forward as far as they were able. They were allowed to rest for one minutes among tries. The best score was the saved one.

Figure 1. Illinois test circuit.



Five countermovement jumps were performed by all athletes. Jump height was recorded using a contact platform Chronojump (Boscosystem® ltda., Spain). The best score for each athlete was saved and also used for calculating jump power using Samozino *et al.*,[26] equation.

All participants performed 3 horizontal jumps, starting on standing position with no previous run and parallel feet. The initial point was tiptoe, having the reference of calcaneus as the finish point.

The last test performed was a specific one, to determinate two groups as A: high Parkour performance; and B: low Parkour performance. The test consisted on a circuit designed by a Parkour expert. This test consisted on reaching seven obstacles where difficulty, execution and element concatenation were scored. Obstacles order were a length jump (3.125 m) with a 1.20 m ramp; a 1.10 m high rail vault using only their hands; two more identic rail vaults being allowed to do any element; a 2.15 m climb in a free way; other rail vault having to do, at least, a 360 degrees turn on the frontal or sagittal axis with no limit on longitudinal axis turns, being allowed to use only their feet; The sixth obstacle was a three elements concatenation where they had to do, at least, 360 degrees turn on frontal or sagittal axis and being allowed to use their hands on the ground; the last of them was another wall climb (2.6m height). On Parkour competitions, there are five judges to assess execution, difficulty, flow and creativity during a circuit. A Parkour expert took charge to define the execution, difficulty and flow punctuation to divide the sample in two groups due to it does not exist a published punctuation code yet, not being measured creativity.

Statistical analysis was done with IBM statics SPSS 20 software. Saphiro-wilk test was used for testing normality of the data and t test for independent samples for determining if there were significant differences among groups.

Results

Anthropometric characteristics, somatotype and body composition are presented on Table 2.

No significant differences appear on skinfold variables, thus there are not significant differences on body fat. Although there are some girths that present significant differences, muscle mass does not appear as a variable with significant differences. Same as body fat, there are not differences between groups on bone mass, perhaps due to an absence of significant differences on breadths variables. It is on two somatotype components, mesomorphy and ectomorphy, where we can observe significant differences between groups.

On Figure 2 we can observe a somatochart for all sample, such as mean of both groups and individual somatotypes for all the athletes. We observe the difference between group A and B on mesomorphy.

Values for physical fitness of both groups are presented on Table 3.

Significant differences between performance groups on physical fitness were observed. Hamstrings extensibility has been presented as a not different variable among groups. The rest of variables measured are presented different between groups scores, thus they seem to be important factors on Parkour performance.

Discussion and conclusions

The main finding of this study were the high differences on mesomorphy, estimated maximal oxygen consumption, horizontal and vertical jump, jump power and agility between groups. So these variables

Figure 2. Somatochart of Parkour practitioners.

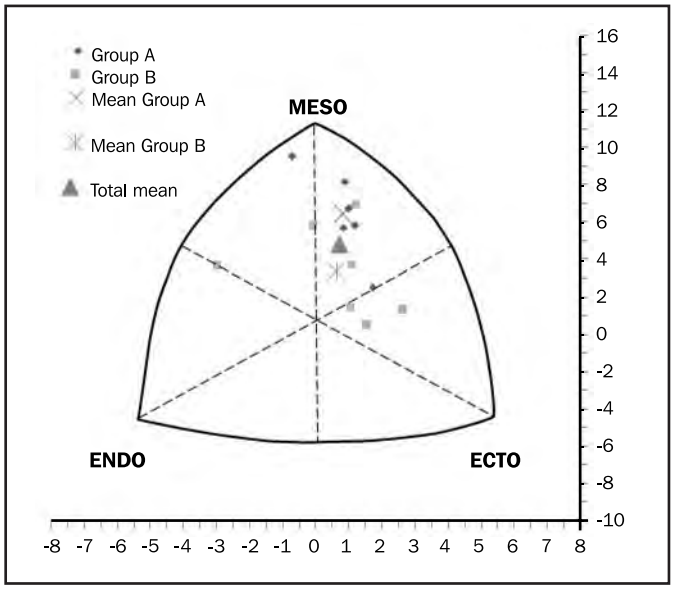


Table 2. Anthropometric characteristics and body composition (Mean ± SD).

	Group A (n=6)	Group B (n=7)	All (n=13)
Height (cm)	178.98 ± 6.55	175.77 ± 6.41	177.25 ± 6.42
Body mass (Kg)	75.47 ± 9.88	66.34 ± 6.16	70.55 ± 9.06
Triceps skinfold (mm)	5.08 ± 0.83	6.41 ± 3.03	5.80 ± 2.31
Subscapular skinfold (mm)	8.07 ± 0.76	9.26 ± 4.56	8.71 ± 3.32
Biceps skinfold (mm)	2.90 ± 0.33	3.31 ± 1.57	3.12 ±.15
Iliac crest skinfold (mm)	9.58 ± 2.04	14.07 ± 5.76	12.00 ± 4.88
Supraspinal skinfold (mm)	5.68 ± 0.73	7.61 ± 2.29	6.72 ± 1.96
Abdominal skinfold (mm)	7.45 ± 1.38	10.33 ± 4.80	9.00 ± 3.81
Front thigh skinfold (mm)	7.61 ± 2.16	11.01 ± 4.99	9.45 ± 4.18
Medial calf skinfold (mm)	5.93 ± 1.33	7.26 ± 3.77	6.65 ± 2.88
Sum of 8 skinfolds	54.63 ± 10.02	69.40 ± 30.70	61.45 ± 22.40
Sum of 6 skinfolds	40.56 ± 6.96	53.05 ± 23.33	46.32 ± 17.12
Arm relaxed girth (cm)	31.05 ± 2.39	28.32 ± 1.82 *	29.58 ± 2.46
Flexed and tensed arm girth (cm)	34.63 ± 2.59	31.07 ± 1.41**	32.71 ± 2.68
Waist girth (cm)	79.68 ± 3.60	74.71 ± 3.18 *	77.00 ± 4.14
Gluteal girth (cm)	94.79 ± 6.02	91.13 ± 5.75	92.82 ± 5.94
Calf girth (cm)	38.03 ± 2.20	35.07 ± 2.38 *	36.43 ± 2.68
Mid thigh Girth (cm)	54.68 ± 4.10	50.40 ± 5.75	52.38 ± 5.34
Humerus breadth (cm)	7.02 ± 0.33	6.63 ± 0.43	6.81 ± 0.42
Bistyloid breadth (cm)	5.66 ± 0.23	5.36 ± 0.28	5.50 ± 0.29
Femur breadth (cm)	9.56 ± 0.69	8.92 ± 0.66	9.22 ± 0.72
Bimaleolar breadth (cm)	7.35 ± 0.72	7.20 ± 0.31	7.27 ± 0.52
Endomorphy	1.7 ± 0.15	2.2 ± 1.01	2 ± 0.77
Mesomorphy	5.3 ± 0.89	4.2 ± 0.94**	4.7 ±1.04
Ectomorphy	2.5 ± 0.73	2.8 ± 0.92*	2.7 ± 0.82
Fat mass percentage	7.50 ± 0.52	8.67 ± 2.13	8.13 ± 1.66
Muscle mass percentage	47.44 ± 2.03	45.91 ± 2.68	46.61 ± 2.44
Bone mass percentage	12.47 ± 0.70	12.53 ± 1.21	12.50 ± 0.98

*p<0,05; ** p<0,01 respect group A

Table 3. Physical fitness (Mean ± SD).

	Group A (n=6)	Group B (n=7)	All (n=13)
Vo_2max (ml/kg/min)	72.80 ± 11.01	55.19 ± 6.06**	63.32 ± 12.35
Illinois test (s)	14.36 ± 0.47	15.29 ± 0.44**	14.86 ± 0.65
Sit & Reach (cm)	13.77 ± 5.20	7.86 ± 12.70	10.58 ± 10.06
Vertical jump height (cm)	50.09 ± 3.47	37.19 ± 4.82***	43.10 ± 7.88
Vertical jump power (W)	2820.84 ± 453.72	2105.84 ± 237.24 **	2435.84 ± 501.55
Horizontal jump (m)	2.97 ± 0.71	2.60 ± 0.22 **	2.77 ± 0.25

*p<0,05; ** p<0,01; *** p<0,001 respect group A.

seem to be determinant factors on Parkour performance. Lower values on ectomorphy also seem to be important on performance.

All components of body composition are presented as not important factors on Parkour performance because of the absence of statically differences among both groups, the same as happened to hamstrings extensibility and endomorphy.

Leite *et al.*[14] described some results on Parkour practitioners. On body mass index they found values of 21.21 ± 2.07, which were very similar to the values we described (22.46 ± 2.22). Their results on maximal oxygen consumption (44.21 ± 5.60 ml•kg^{-1}•min^{-1}) differs from the findings presented here (63.32 ± 12.35 ml•kg^{-1}•min^{-1}). On jumping variables, higher values for horizontal jump were described on the present study (2.77 ± 0.25 m) while they got values of 2.53 ± 0.21 m. Our results were lower on sit and reach (10.58 ± 10.08 cm) than Leite *et al.*, Subjects[14] (23.54 ± 8.32 cm). Warren *et al.*,[27] described results for fat mass of 7.26 ± 1.32% which were very similar to the values of the athletes from this study (7.50 ± 0.52%). Otherwise, in contrast to their study, we got results of 5100.58 ± 141.29 W for vertical jump power while they

got 6234.32 ± 619.00 W, using the Sayers *et al*.,[28] cited in Carlock *et al*.,[29] equation for jump power.

When comparing with other sports, such as gymnastics, we can observe the higher results on vertical jump (43.10 ± 7.88 cm) while other authors have found lower values like 37.22 ± 6.19[30], 38.50 ± 0.9[31], 40.10 ± 1.2 cm[32]. There are also big differences in somatotype, while we got values of 2.0-4.7-2.7, other studies present values of 2.4-4.7-2.8[33], 1.7-6.3-1.6[34] and 1.8-7.1-1.6[35]. Then we can observe our higher values on ectomorphy, but lower scores on mesomorphy. On the other hand we observe similar values in endomorphy. When comparing our 8.13 ± 1.75% of body fat value, the results in gymnastics were 7.13 ± 1.60[33] and 11.34 ± 1.6, so the body fat percentage appears lower on traceurs than gymnastics athletes.

Comparing the variables of horizontal jump and agility with other sport's athletes, it can be observed, also, the higher values for Parkour practitioners, even higher than other sports where the measured condition is the specific movement on the respective sport. Traceurs got scores of 14.86 ± 0.65 s on Illinois test, founding values of 16.28 ± 0.57 s on soccer players[36], 17.40 ± 0.90 s on Rugby players[37], 15.87 ± 0.47 s on squash players[38] and 16.88 ± 0.86 on hand ball players[39]. Our results have not previously been described. On horizontal jump, the traceurs of our study got values of 2.77 ± 0.25 m, while the results on soccer players are 2.39 ± 0.14[40], 2.72 ± 0.14 on sprinter and 2.72 ± 0.13 on long jump athletes[41].

This study set out to determine that the most important performance factors on Parkour practitioners are high values on mesomorphy, vertical jump height and power, horizontal jump, maximal oxygen consumption and agility and low values on ectomorphy. Parkour is also presented as an effective training method for development of high levels of horizontal and vertical jump and agility, getting higher scores even in horizontal jump than in long jump athletes

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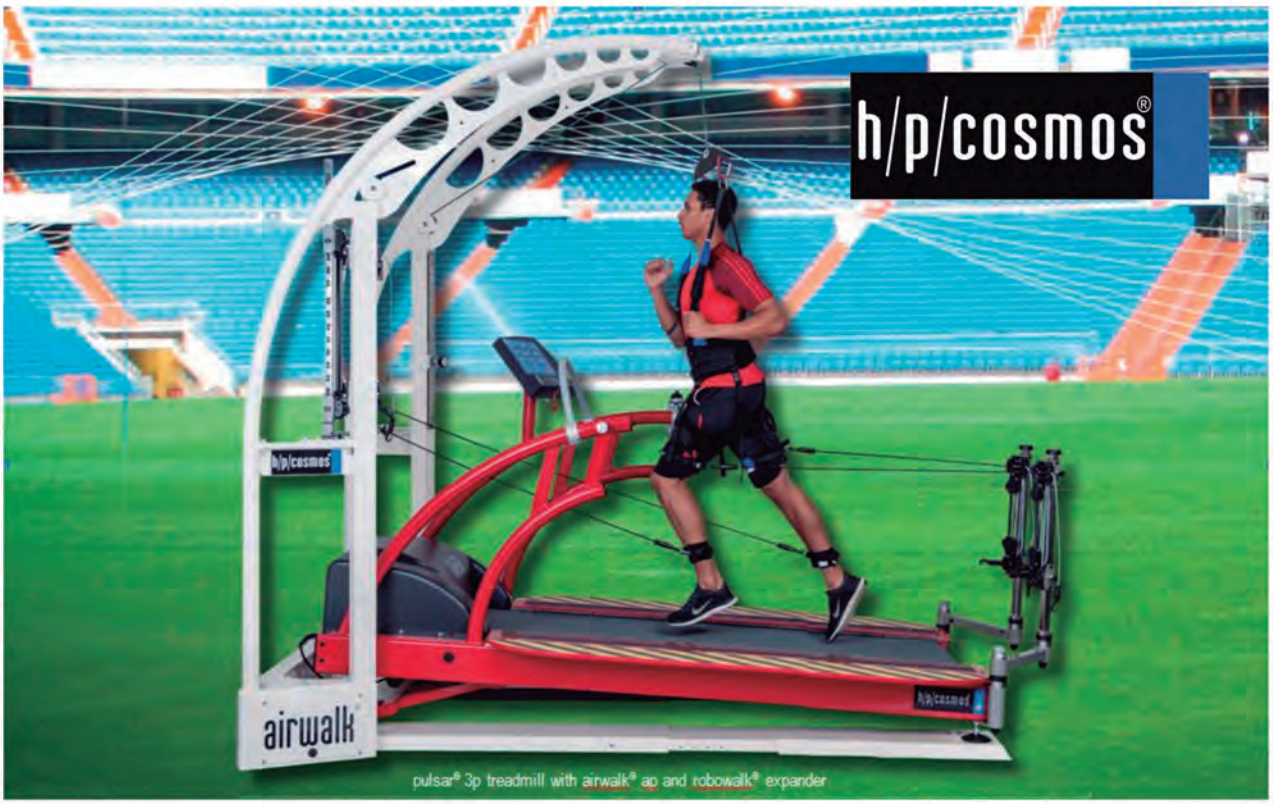
RehaRunning©, entrenamiento y rehabilitación con sistema antigravedad

Entrenamiento y Rehabilitación

Utilizando los distintos componentes diseñados por **h/p/cosmos**, le ofrecemos una solución que nos permite disminuir el peso del paciente o deportista hasta un máximo de 120 Kg, para realizar tanto ejercicios de rehabilitación (de articulaciones, huesos o muscular) como de entrenamiento, ademas de aquellos casos de protección de sobrecarga anterior a una prueba deportiva, fascitis plantar, etc.

Ademas, puede utilizarlo también para otras aplicaciones como pruebas de esfuerzo, análisis de gases, estudios biomecánicos con análisis óptico, etc. Tanto en un tapiz rodante nuevo, como con el que ya disponga de la marca.



Ejemplos de ejercicios de musculación y carrera, con pendiente positiva o negativa

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- Tapiz rodante, por ejemplo **Pulsar 3P** con una velocidad de hasta 40 Km/h
- Sistema antigravedad **Airwalk ap** con una descarga máxima de 80 o 120Kg (dos versiones) y altura max. del usuario de 220cm.
- Sistema de musculación mediante tensores delanteros y traseros **Robowalk expander** de aplicación simultanea a la carrera.

y pueden integrarse distintas soluciones para estudios biomecánicos y mejora de la carrera como:

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Age-related differences in physical and physiological characteristics in male handball players

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Summary

Aim: Although there are studies on physical and physiological characteristics of handball player, few that process different ages in the same study. The objectives of this study were to examine the variation in physical and physiological characteristics in male handball players according to their age.
Methods: Adolescent and adult players (n = 96) were examined for anthropometric characteristics, somatotype and body composition, and performed the physical working capacity in heart rate 170 min^{-1} test, a force-velocity test, the Wingate anaerobic test (WAnT), sit-and-reach test (SAR), handgrip strength test (HST), squat jump, countermovement vertical jump without (CMJ) and with arm-swing (CMJarm), and a 30-s Bosco test.
Results: An improvement is observed with aging, to most important parameters for the handball player, such as improvement in anthropometric and somatotype characteristics, jumping ability (CMJ, CMJ with arm and SJ) and increased power.
Conclusion: It is concluded that there are differences between age groups, which between them include anthropometric characteristics (eg taller players more mesomorphic and less FFM), greater jumping ability in different variants is around 22-24% for adulthood; while power makes around 30%. It increased over time flexibility stands; and a sub-maximal heart rate more efficient along age. These studies contribute to a better understanding by the coaches of the evolution of the physical and physiological characteristics in a specialty such as handball.

Key words:
Growth and development. Sport. Physical fitness. Age groups.

Diferencias relacionadas con la edad en las características físicas y fisiológicas en jugadores de balonmano masculino

Resumen

Objetivo: A pesar de existir estudios sobre características físicas y fisiológicas del jugador de balonmano, son escasos los que tratan diferentes edades en un mismo estudio. El propósito de este artículo fue examinar la variación en las características físicas y fisiológicas en jugadores de balonmano acorde a su edad.
Método: Se seleccionaron un total de 96 jugadores de balonmano jóvenes y adultos, a los que se les realizó una evaluación de las características antropométricas, somatotipo y composición corporal, capacidad de trabajo en el test 170 lat•min^{-1}, test de fuerza-velocidad, test Wingate, test *sit and reach*, fuerza de prensión manual, salto con contramovimiento (con y sin brazos), *squat jump* y test de bosco 30 s.
Resultados: Los resultados indican diferencias estadísticamente significativas en prácticamente todas las variables analizadas. Se observa una mejora según avanza la edad, hacia parámetros más importantes para el jugador de balonmano, como son mejora en características antropométricas y somatotipo, capacidad de salto en su diferentes versiones e incremento de la potencia.
Conclusiones: Se concluye que existen diferencias entre los grupos de edad, donde entre las mismas destacan características antropométricas (jugadores con mayor talla, mayor componente mesomórfico y menos MLG), mayor capacidad de salto en sus diferentes variantes que se muestran en torno al 22-24% para la edad adulta; mientras que la potencia lo hace entorno al 30%. Se destaca el incremento a lo largo del tiempo de la flexibilidad; así como una frecuencia cardiaca sub-máxima mas eficiente a lo largo de la edad. Estos datos pueden contribuir al mejor conocimiento por parte de los entrenadores de la evolución de las características físicas y fisiológicas en una especialidad como el balonmano.

Palabras clave:
Crecimiento y desarrollo. Deporte. Condición física. Grupos de edad.

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Introduction

Handball is an Olympic contact team sport with intermittent movements such as jumping, sprinting, throwing, blocking, etc. interspersed with continuous activities such as walking and running in response to different attacking and defensive situations[1-5].

Understanding the anthropometric profile or physical characteristics may be a useful means of identifying talent, facilitating the assigning of playing positions and helping find the optimum design of strength and conditioning training programmes[6,7].

It is important to establish the body composition of athletes because components such as bone, muscle and fat mass are related to performance. Studies show an increase in the height and body mass index with age. The handball players younger than 16 years, are 1.68 - 1.75 m tall and weigh between 22-23 kg•m^2 [2,8]. Adult players are around 1.81 to 1.92 m tall and weigh 24 to 25 kg•m^2 [3,7,9,10]. Ibnziaten *et al.* [11] analysed the anthropometric characteristics of 10 to 14-year olds, and Zapartidis *et al.*[12] those of 12 to 15-year olds, but these are isolated studies, in which it would be necessary to appreciate these differences in comparison to adult players, whilst also including interesting variables for handball, such as, for example, the fat mass, fat-free mass, somatotype, etc. as these anthropometric factors and morphological features may have an impact on the effectiveness of the play.

Furthermore, handball is a very complex sport and success depends on a series of abilities such as specific strength, power, speed and resistance. Creativity in play, in combination with speed, strength and coordination, make this a very attractive yet difficult game to master. The appearance of these characteristics and their interaction have led to a large number of scientists from around the world undertaking research in this field[10]. Performance in various motor tasks improves throughout childhood and adolescence, and this seems to be an important predictor of future performance. It is known that during adolescence, male players improve considerably[13]. Basic motor skills can be considered to be a complete assessment of the majority of the bodily functions in daily physical activity. Indirectly, the studies may reveal the differences between the age groups. It would appear that adults have more strength and speed compared to adolescent handball players[2,7,12], but again, these are isolated studies that do not use the same research methodology and the players are not of the same nationality.

Therefore, it is still important to delve deeper into the effect of age on the physical and physiological characteristics of handball players. The aim of this study was to examine the variation of the physical and physiological characteristics in accordance with three age groups (<15 years, <18 years and adults).

Material and method

96 male handball players were selected and divided up into 3 age groups: < 15 years group (n=32): with 2.0 ± 0.9 years of handball training experience and a weekly training volume of 4.0 ± 0.8hrs; <18 years group (n=26): with 4.0 ± 1.7 years of handball training experience and a weekly training volume of 5.9 ± 1.8hrs; adult group (n=38): with 14.4 ± 6.1 years and a weekly training volume of 8.4 ± 2.0 hrs. In total, to achieve a general representation of the handball player, we selected 17 goalkeepers, 34 central players, 30 wing players and 15 pivots. All the players belonged to the Greek National Premier League, each in their corresponding category.

The assessments were performed during the competitive season. The protocols were performed in accordance with the Helsinki Declaration and were approved by the local institute where the study was undertaken. All the players volunteered to participate in this study, signing an informed consent form, which was completed by their legal guardians in the case of subjects under the age of 18. This all occurred after they were explained the objectives, procedures and characteristics of the study. The exclusion criteria were: having an antecedent of any kind of chronic injury and the long-term consumption of medication.

The tests performed are described below:

Anthropometric assessment: Measurements were taken of the height, body mass, skin folds, body mass index (BMI), which is calculated as the ratio between the body mass (kg) and squared height (m^2). Body fat is measured based on the sum of 10 skin folds[14]. An electronic scale (HD-351,Tanita, Illinois, USA) was used to measure the body mass (precision 0.1kg), a stand-alone stadiometer (SECA, Leicester, United Kingdom) for the height measurement (0.001m) and a skinfold calliper (Harpenden, West Sussex, United Kingdom) for the skinfolds (0.5mm).

A two-component model was used for the body composition, which divides the body into fat mass, calculated as the product of the body mass by the percentage of body fat, and the fat-free mass, calculated as the difference between the body mass and the fat mass. At the same time, the Heath-Carter anthropometric method was used to establish the somatotype, which was expressed in three components: endomorph, mesomorph and ectomorph[15].

Sit and Reach Test: The players sat on the floor with their knees flat and their feet hip distance apart, with their ankles flexed at 90º. The soles of their feet were positioned perpendicular to the ground against the measuring box, and the tips of their toes were pointing upwards. In this position they were asked to bend their trunk forward as far as possible, keeping their knees and arms straight. The palms of their hands, one next to the other, slid along the box to reach the furthest distance possible. The subjects had two attempts, noting the greatest distance of the two in centimetres[16].

Physical work capacity (PWC170): This test was performed in accordance with the protocol established by the Eurofit[17] test battery on a cycle-ergometer (828 Ergomedic, Monark, Sweden). The height of the seat was adjusted to the subject, who sat with his/her feet on the pedals with straps to prevent the feet from slipping. The participants were instructed to pedal at a rate of 80 revolutions per minute, using a visual reference as a guidance on the cycle-ergometer screen. The PWC 170 test consists of three stages, each lasting 3 mins, against the strength of a gradual brake with the aim of obtaining a heart rate of between 120 and 170 beats per minute. The result is based on the linear relationship between the heart rate and power or the work load, expressed as W•kg^{-1}.

Counter Movement Vertical Jump (CMJ), Squat Jump (SJ) and Abalakov: The subjects had two attempts at each of the jumps, with the best result noted[18]. The height of the jump was measured using the

Opto-jump strength platform (Microgate Engineering, Bolzano, Italy), given in cm.

Modified Bosco 30s Test: The same equipment was used as for the CMJ test. The participants were instructed to jump as high as possible, with their feet touching the floor for as short a time as possible[19]. The average power during the 30s test was noted as $W.kg^{-1}$.

Manual pressure strength: The subjects stood upright with their legs slightly apart and their hands extended vertically down alongside their trunk, yet not touching it. In this position the subject had to press on the dynamometer handle (Takei, Tokyo, Japan) as hard as possible for 5s[17]. Two attempts were made and the result was considered to be the sum of the best on each hand, divided by the body mass and expressed as $kg•kg^{-1}$ of the body mass.

Strength-Speed Test (S-S): This test was used to assess maximum anaerobic power, which is expressed as $W•kg^{-1}$. This test uses different braking strengths which provoke different pedalling speeds with the aim of achieving maximum power[20]. The participants performed four 7-second cycles against an increasing braking force (2,3,4 and 5 kg) on a cycloergometre (Ergomedics 874, Monark, Sweden) which were broken up with 5-minute rest periods.

Wingate test: The Wingate test[21] was performed using the same cycloergometre as the strength-speed test. Participants were required to pedal as fast as possible for 30 seconds against a braking force that was determined by the sum of the body mass in kg by 0.075. The average power (Paverage) was calculated as the average power during the 30s period and was expressed as $W•kg^{-1}$.

Statistical analysis

The statistical analysis was performed using the IBM SPSS v.20.0 programme (SPSS, Chicago, USA). The data was expressed as an average and standard deviation of the average (SD). To observe the possible differences between the age groups in the physical and physiological characteristics, a variance analysis was used of one factor (ANOVA) using the Tukey process as a post hoc analysis. The significance level was set at $\alpha = 0.05$, and the difference of the average along with the confidence intervals of 95% (CI) was calculated when the post hoc was necessary. Furthermore, the discriminant analysis was used for the physical and physiological characteristics with the age group variable as dependent.

Results

Table 1 reveals the physical characteristics and body composition of the different age groups.

Table 2 reveals the physiological characteristics of the different age groups.

Table 3 reveals the heart rate response of the different groups in two of the tests undertaken.

Discussion

The aim of this study was to observe the possible variations in anthropometric, physical and physiological parameters during the growth and formation process over the years of handball training, observing them within different age groups. These changes have been observed across all the groups, suggesting that the subjects tend to improve their performance and body composition with age. The results reveal significant differences when comparing all the ages (Tables 1, 2 and 3).

The average values of the body composition parameters reveal significant differences (<15, <18 and adults), especially in body mass, height, BMI, FFM and WH Ratio (Table 1). The results on an anthropometric level are aligned with the values shown in previous research studies, highlighting an increase in height with age (Table 1). More

Table 1. Physical characteristics and body composition in adolescents and adults according to age group.

	<15 years (n=32)	<18 years (n=26)	Adults (n=38)	ANOVA
Age (years)	13.8±0.7†‡	16.3±0.7*‡	26.8±5.6*†	$F_{(2.93)}$ = 130.94, p<0.001, η^2=0.738, Large SE
Body mass (kg)	64.7±12.3†‡	72.2±9.1*‡	87.5±8.3*†	$F_{(2.93)}$ = 47.52, p<0.001, η^2=0.505, Large SE
Height (m)	1.70±0.08†‡	1.77±0.08*‡	1.85±0.07*†	$F_{(2.93)}$ = 36.96, p<0.001, η^2=0.444, Large SE
BMI ($kg.m^2$)	22.4±3.8‡	23.0±2.4‡	25.7±2.2*†	$F_{(2.93)}$ = 12.98, p<0.001, η^2=0.218, Large SE
BF (%)	18.7±6.1	16.9±4.5	18.3±3.6	$F_{(2.93)}$=1.07, p=0.348
FFM (kg)	52.1±7.6†‡	59.8±6.6*‡	71.4±5.6*†	$F_{(2.93)}$ = 75.96, p<0.001, η^2=0.620, Large SE
WH ratio	0.77±0.04‡	0.78±0.05‡	0.81±0.04*†	$F_{(2.93)}$ = 10.81, p<0.001, η^2=0.188, Large SE
Endomorph	4.5±2.2	3.7±1.5	3.8±1.1	$F_{(2.93)}$=2.10, p=0.128
Mesomorph	4.7±1.4	4.6±1.2‡	5.4±1.1†	$F_{(2.93)}$ = 4.08, p=0.020, η^2=0.081, Medium SE
Ectomorph	2.7±1.6	2.7±1.2	2.0±0.9	$F_{(2.93)}$ = 3.61, p=0.031, η^2=0.072, Medium SE

BMI: body mass index; BF: body fat; body fat percentage; FFM: fat-free mass; WH ratio: waist-hip ratio; SE; size of the effect. The symbols *, † and ‡ show the difference between <15, <18 and adults, respectively.

Table 2. Physiological characteristics in adolescents and adults.

	<15 years (n=32)	<18 years (n=26)	Adults (n=38)	ANOVA
PWC_{170} ($W.kg^{-1}$)	2.25±0.77†‡	2.98±0.76*	3.04±0.67*	$F_{(2.90)} = 11.54$, $p < 0.001$, $\eta^2 = 0.204$, Large SE
P_{max} ($W.kg^{-1}$)	12.2±2.6‡	12.6±2.6	13.9±2.0*	$F_{(2.88)} = 4.43$, $p = 0.015$, $\eta^2 = 0.091$, Medium SE
$P_{average}$ ($W.kg^{-1}$)	7.2±1.2†‡	8.2±0.7*	8.4±0.5*	$F_{(2.86)} = 19.60$, $p < 0.001$ $\eta^2 = 0.313$, Large SE
SAR (cm)	17.6±7.8‡	19.3±9.3	23.4±9.0*	$F_{(2.93)} = 4.11$, $p = 0.020$, $\eta^2 = 0.081$, Medium SE
MS ($kg.kg^{-1}$)	1.17±0.26‡	1.30±0.23	1.34±0.18*	$F_{(2.93)} = 5.51$, $p = 0.006$, $\eta^2 = 0.106$, Medium SE
SJ (cm)	26.4±5.2‡	29.4±5.6‡	33.9±4.9*†	$F_{(2.90)} = 18.04$, $p < 0.001$, $\eta^2 = 0.286$, Large SE
CMJ (cm)	27.7±5.4‡	30.2±5.8‡	35.8±5.4*†	$F_{(2.90)} = 19.33$, $p < 0.001$, $\eta^2 = 0.300$, Large SE
ABK (cm)	32.8±6.8†‡	37.4±6.4*‡	43.6±5.7*†	$F_{(2.90)} = 24.94$, $p < 0.001$, $\eta^2 = 0.357$, Large SE
Bosco ($W.kg^{-1}$)	23.6±5.1†‡	29.7±5.2*‡	34.3±6.0*†	$F_{(2.90)} = 32.10$, $p < 0.001$, $\eta^2 = 0.416$, Large SE

PWC170: physical work capacity at 170 beats-min^{1}; P_{max}: maximum estimated power in the strength-speed test; $P_{average}$: average power during the Wingate test; SAR: sit-and-reach test; MS: manual strength: SJ: squat jump; CMJ: counter movement jump; ABK: Abalakov jump; SE: size of the effect. The symbols *, † and ‡ show the difference between <15, <18 and adults, respectively.

Table 3. Heart rate response in the Wingate and Bosco test on adolescents and adults.

		<15 years (n=32)	<18 years (n=26)	Adults (n=38)	ANOVA
WAnT	min^{-1}	186.1±10.1†‡	176.5±10.8*	173.0±12.2*	$F_{(2.86)} = 11.84$, $p < 0.001$, $\eta^2 = 0.216$, Large SE
	%	90.2±5.0†	86.7±5.3*	89.4±5.9	$F_{(2.86)} = 3.16$, $p = 0.048$, $\eta^2 = 0.069$, Medium SE
Bosco	min^{-1}	169.2±13.4†‡	156.5±12.9*	159.2±13.9*	$F_{(2.86)} = 7.32$, $p = 0.001$, $\eta^2 = 0.148$, Large SE
	%	82.1±6.5†	76.8±6.3*‡	82.1±6.7†	$F_{(2.86)} = 5.65$, $p < 0.005$, $\eta^2 = 0.119$, Medium SE

The symbols *, † and ‡ show the difference between <15, <18 and adults, respectively.

specifically, there are many studies that reveal an average height of around 1.68-1.75 m in <15 years[2,12], around 1.77 m in <18 years[22] and between 1.81 to 1.92 m in adults[3,7,10,23]. Similarly, statistically significant differences have been revealed in the height between elite-level and lesser-level players[23]. This could indicate that the biological maturity of the players is not attained until adulthood.

Likewise, the evolution of the body mass is related to the age of the handball players (Table 1). In literature, these values are positioned between 40 to 70 kg in <15 years[2,11]; around 69 kg in <18 years and between 78 to 96 kg in adults[2,3,5,7,10,23-25]. Savucu[26] suggest that taller and heavier handball players have the capacity to reach greater speeds in jumping throws, which is essential in this sport.

Similar to the previous anthropometric variables, the average BMI results were very similar in comparison to previous research studies. In <15 years the data range is made between 22 to 23 $kg/m^{2(2)}$, in <18 years at around 22 $kg/m^{2(22)}$ and between 24 - 25 kg/m^2 in adults[3,7,9,10]. Although BMI can be an erroneous indicator when determining the degree of obesity[27], it is true that it can offer valuable information when observing the evolution over age, and, at the same time, studying the relationship between the BMI and body fat, as indicated in other team sports[28]. According to Visnapuu and Jürimäe[22], another important factor regarding the body composition parameters is that height, body mass and the BMI are more important in handball players than other variables, for example hand grip strength.

The evolution of body fat with age does not follow the same pattern as the previous variables (Table 1). In fact, our data does not match with that described by Ibnziaten *et al.*[11], who propose that body fat percentage decreases with the age and competitive level of handball players, similarly to other team sports such as football[28]. Our values were similar to those put forward by Nikolaidis & Karydis[29], who indicated that the evolution of body fat with age did not have to be linear. In addition, the body fat findings are slightly higher than those in previous studies in which for <15 years it was positioned between 14 to 16%[11], and in adults between 11 to 15%[3,5,7,10,23-25]. A high percentage of body fat has a negative effect on performance and health in team sports[28], which is why both players and trainers alike should be take it into consideration.

Fat mass is also an interesting parameter with regards to growth[30]. Fat-free mass increases throughout the age groups established in this study, just as indicated in previous studies[11,28]. Specifically, the group of adults (71.4 kg) is aligned with the suggestions of other studies that position it between 65 and 82 kg[3,5,29,31]. In our study, there are highly significant differences between the groups, which are even more notable than the WH ratio increase towards adulthood. In previously conducted

studies, it has been observed how elite players were taller and had more fat-free mass than amateur players[32]. Ibnziaten *et al.*[11] indicate a possible causal relationship between training throughout childhood and adolescence and a tendency to have a healthier constitution, i.e. less body fat and more muscle mass. It has been suggested that differences in fat-free mass may lead to greater differences in variables such as strength and power, which result in an improvement of the muscle mass towards adulthood. Vila *et al.*[4] indicate that muscle mass is important for handball players, as greater muscle weight and strength may be an advantage when tackling defenders on the 6-metre line. Greater strength and maximum power in elite players implies having an advantage in basic handball actions, such as blocking, hitting, pushing and gaining possession[33].

Endomorphic and ectomorphic components of the somatotype reveal significant values between <15 years and <18 years, with no differences among adults (Table 1). However, the mesomorphic component increased notably within the <18 years group and the adult group. Similar results were found by Nikolaidis y Karydis[29], where the endomorphic and ectomorphic factor reduced throughout adolescence, whilst the mesomorphic factor increased.

Bayios *et al.*[34] revealed that handball players had higher values in the mesomorphic and endomorphic component and less in the ectomorphic component than basketball and volleyball players, aligned with our results (Table 1). In turn, if this data is observed with other team sports, it can be seen how handball players have higher values in body fat, an endomorphic and mesomorphic component, even more apparent when comparing sexes[4,29,30,34,35]. Likewise, the lowest value was obtained in the ectomorphic component (Table 1), aligned with the results displayed in Vila *et al.*[4]. Numerous authors have reinforced this fact, indicating that the anthropometric characteristics of handball players are important because there are repeated physical contact actions and a large number of collisions, meaning that small differences in these components may or may not be an advantage[9].

Physiological characteristics

An increase is observed with the progression of age in all the variables related to the functional assessment of the player (Table 2). For example, regarding hand grip strength, values have been found in players of around 171 and 285 N in those under 15 years and between 414 and 472 N in under-18s[22], observing an increase with the progression of age. These differences in hand grip strength in elite players are higher when compared to amateur players[32]. Accordingly, significant differences have been found between under-15s and adults. HGS seems to be related to anthropometric parameters, in which it has been observed that the taller players with greater body mass are more likely to have better results in this variable[22]. Therefore, controlling this parameter could be useful for trainers. The essential capacity of gripping the ball should not be overlooked in handball[4], which is why strength seems to be crucial in the success of this sport, with the aim of throwing and controlling the ball during the game. These conclusions are compatible with other studies, which indicate that throwing speed and precision are considered some of the most important elements in handball[32], aspects linked to the ability to grip, therefore obtain a high value in the hand grip strength test.

The average values of the sit-reach test reveal that the result increases from young people to adulthood. The results obtained may seem low (Table 2), but they are within those proposed by other authors. The data oscillates between 15 to 34 cm in under-15s, with the best of the 18 years at around 32 cm. The results in women are higher in both ages, between 31 and 39 cm[2,8,12,28]. It is curious that the values continue to increase, without any statistical significance between the under-15s group and the 18-years group, but with significance in the adult group (Table 2). This variable is interesting because the increase is of approximately 24% from <15 years to the adult group. It may be that over the years, handball training improves this quality due to the specific nature of the training. It is true that one of the limitations of this study is that the training load performed by the players has not been assessed, i.e. the amount of training targeting strength or resistance. Therefore it would be interesting to assess this because in a quality that tends to reduce over time, its increase may be due to a greater training load as the specialisation increases.

It has been observed that jumping capacity increases depending on the age group in all the jumps assessed (Table 2). The adult players achieved SJ values of around 32-35 cm, similar to results from other studies[36]. In terms of the CMJ, similar results were gathered to those for under-15 years football players, between 30 to 34 cm[28], and in adults with a range between 34-40 cm[3,36,37]. A sport like handball entails jumping as high as possible and throwing at maximum speed[3,12,26], therefore it is logical that over the years of training these variables increase. Our results reveal that muscle mass seems to be an important factor that is fundamentally linked to jumping performance. In accordance with this, Sporis and Vuleta[10] highlighted the association between weight and fat mass with the jump test. Therefore, these results show the importance of developing jumping capacity from adolescence, controlling the improvement in the muscle mass for greater success in the adult phase.

Performing an analysis over time, it can be seen how percentages of improvement in the <15 years to the <18 years is in an interval of 8-12%; with the difference in the adult group being around 22-24%. As such, jumping capacity increases gradually with age and with the level of specialisation.

In this respect, regarding power, the improvement with age obtains higher values, i.e. changes of 20% in the younger groups and up to 31% improvement for the adult group. It is acknowledged that training programmes of between 6 and 10 weeks can improve power[38]. Souhail *et al.*[39] reveal how aerobic power is related to the distance covered during the game; and in this respect an adult player covers twice as much distance as adolescents in a game[40]. Considering the intermittent nature of this team sport, it has been claimed that performance is

associated with the capacity to produce high power output for a short length of time (anaerobic power) and the capacity to recover between these high intensity actions (aerobic power)[41]. This can be observed in the statistically significant differences between the age groups (Table 2), marking greater differences between formation and the group of adults in this quality than in a jump.

In turn, a cardiovascular adaptation can be observed with increasing age (Table 3). Wagner *et al*[42] highlight the need to control cardiovascular parameters due to their significant implication in handball competition. This is a hugely important parameter in being more effective in the game. The differences between groups, despite being significant, are more marked than in other qualities.

Therefore, the anthropometric and physiological values are very similar to existing data in literature for handball players of the same age, however, from our point of view trainers should focus on some parameters that may be highly useful. Firstly, some anthropometric characteristics should be considered (for example taller players with greater mesomorphic component and less FFM), because it is likely that this profile will perform better in the future. Databases that include information about different ages could facilitate benchmark values for the trainer and the player's evolution over time. Secondly, power and strength data should be noted, as improvement percentages throughout the age groups may be useful as a starting point to understand the evolution of these variables in handball players, and this may allow for better planning over time. The majority of the findings in this study focus on the importance of training over the years, physical, physiological and anthropometrical improvement,, especially regarding jumping performance, muscle mass and less FFM, which are vital in successful handball.

Therefore, it can be concluded that there are differences between the age groups, within which certain anthropometric features stand out (tall players, greater mesomorphic component and less FFM), greater jumping capacity in their different variants that can be seen in around 22-24% for adults; whilst potential is revealed at around 30%. A notable consideration is increased flexibility over time; as well as a more efficient sub-maximum heart rate over the years. This data may contribute to enhancing the understanding of trainers regarding the evolution of the physical and physiological characteristics in a speciality such as handball.

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Effectiveness of a customised, unsupervised 4 month exercise programme, on exercise tolerance, perception of fatigue and anthropometric variables in sedentary patients with cardiovascular risk factors

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Summary

Introduction: Improving the physical condition is related to health benefits. The objective of this study is to assess the effectiveness of an individualized unsupervised exercise program on anthropometric variables, the perception of fatigue and physical effort tolerance (6 minutes walking test) in sedentary patients with cardiovascular risk factors.
Material and Methods: We studied 119 sedentary patients with cardiovascular risk factors, aged between 21 and 77 years old. Only 75 patients completed the study (45 women and 30 men). Before beginning the exercise program a medical examination was conducted, including: medical history, physical exam, blood pressure measurement (BP), rest-electrocardiogram (rest-ECG), anthropometrical measurements (weight, height, body mass index (BMI) and impedanciometry. The six minutes walk test was performed at the beginning and end of the study. The distance, BP, heart rate, oxygen saturation and perceived effort were measured.
The 4 month exercise program included: walking for about 30-60 minutes/day, cycloergometer: 3 days/week, 30 minutes each session, intensity of 40-60% of individual maximum functional capacity, isometric abdominal and static stretching.
A descriptive statistical study and a comparison of means for paired data were realized.
Results: The data at the beginning *versus* the end of the exercise program were:
Weight: 100,63 (24,29) *vs.* 99,6 (23,32) (p<0,05) kg; BMI: 36,62 (8,47) *vs.* 36,23 (8,12) (p <0,05) kg/m^2. Fatigue perception, Borg Scale: 4,15 (2,37) *vs*. 2,93 (1,81) (p <0,001). The distances covered were: 474 (61) *vs*. 514,6 (69,2) (p <0,001) meters.
Discussion and Conclusions: The results of the study confirm that the exercise program implemented in our center improves exercise tolerance, reduces the perception of fatigue and even slightly decreases the weight and the BMI, in sedentary patients with cardiovascular risk factors.

Key words:
6 minutes walk test.
Cardiovascular risk factors.
Aerobic endurance.
Effort tolerance.
Physical condition.
Fatigue perception.

Efectividad de un programa de ejercicio físico individualizado no supervisado, de cuatro meses de duración, sobre la tolerancia al esfuerzo, percepción de fatiga y variables antropométricas en pacientes sedentarios con factores de riesgo cardiovascular

Resumen

Introducción: La mejora de la condición física se relaciona con beneficios para la salud. El objetivo de este estudio es valorar la efectividad de un programa de ejercicio físico individualizado no supervisado sobre variables antropométricas, la percepción de fatiga y la tolerancia al esfuerzo (test de los 6 minutos) en pacientes sedentarios con factores de riesgo cardiovascular.
Material y métodos: Se estudiaron 119 pacientes, de los cuales terminaron el estudio 75 (45 mujeres y 30 hombres), con edades comprendidas entre los 21 y 77 años, sedentarios con factores de riesgo cardiovascular. Previo al inicio del programa de ejercicio físico se sometieron a un examen médico-deportivo que incluyó: anamnesis, exploración por aparatos, toma de tensión arterial (TA), electrocardiograma de reposo (ECG), estudio antropométrico (peso, talla, IMC e impedanciometría). Al principio y final del estudio se realizó el test de lo 6 minutos que mide la distancia recorrida y se valoró al inicio y final del test: TA, la frecuencia cardiaca, la saturación de oxígeno y solo al terminar, la percepción de esfuerzo.
El programa de ejercicio físico, de 4 meses de duración, incluyó: caminar 30–60 minutos /día, bicicleta estática: 3 días/semana, 30 minutos/sesión, con una intensidad del 40-60% de la capacidad funcional individual máxima, abdominales isométricos y estiramientos estáticos.
Se realizó estudio estadístico descriptivo y comparación de medias para datos apareados.
Resultados: Los datos al comienzo *versus* el final del programa de ejercicio físico fueron los siguientes: Peso: 100,63 (24,29) *vs.* 99,6 (23,32) (p <0,05) kg; IMC: 36,62 (8,47) *vs.* 36,23 (8,12) (p <0,05) kg/m^2; Percepción de fatiga. Escala de Borg: 4,15 (2,40) *vs.* 2,93 (1,81). (p <0,001). Las distancias recorridas fueron: 474 (61) *vs.* 514,6 (69,2) metros. (p <0,001).
Discusión y conclusiones: Los datos del estudio confirman que el modelo de programa de ejercicio físico individualizado no supervisado aplicado en nuestro centro en pacientes sedentarios con factores de riesgo cardiovascular mejora, de forma estadísticamente significativa: la tolerancia al esfuerzo, la sensación de fatiga y, aunque discretamente, el peso y el IMC.

Palabras clave:
Test de los 6 minutos.
Riesgo cardiovascular.
Resistencia aeróbica.
Tolerancia al esfuerzo.
Condición física.
Percepción de fatiga.

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Introduction

Current scientific evidence highlights that the most important health benefits gained from physical exercise are focused in cardiovascular or metabolic illnesses, those affecting the locomotive apparatus, certain types of cancer and psychiatric illnesses[1-3].

Healthy physical exercise must have some determined characteristics, both in the type of activity as well as the frequency, duration and intensity, and should be orientated towards improving some of the qualities of the health-related physical condition, in particular with cardiorespiratory resistance.

In clinical practice, it can be observed how primary illnesses, such as those presented by patients that are attended frequently in our health care centres, can give rise to a deficit that leads to a sedentary lifestyle of the patient and a subsequent physical de-conditioning that will lead to a worsening of the pathology.

On a physiological level, in patients with moderate-level pathologies, modifications occur to the peripheral muscle, including in particular, the decrease of muscle mass and strength, more marked in the lower extremities, a reduction of type I and IIa fibres, of myoglobin and capillarisation, of oxidative enzymes and energy substrates, which will lead to a decrease in endurance (cardiorespiratory resistance)[4].

A lack of training results in a peripheral myopathy in these patients, due to the reduction of the aerobic metabolic pathway and the development of the anaerobic metabolic pathway.

Thus, once the illness has appeared, and faced with a lack of appropriately applied physical exercise as one of the therapeutic strategic pillars, there is a reduction in the degree of physical activity performed, an increase in sedentary lifestyle habits and a progressive loss of functional capacity, closing a perpetual vicious circle of decline and a progressive worsening of the state of health[5].

Performing regulated physical exercise on a regular basis (correctly prescribed depending on medical and physiological criteria), this process can be reversed.

Prescribing exercise should be based on customisation, i.e. adapting the prescription as far as possible to the characteristics of each patient[6,7].

When prescribing physical exercise, the frequency and duration are still generally accepted standards, but there should be a more in-depth analysis of physiological customisation in the re-training programme (intensity). There are different approximations of this physiological customisation, including: the ventilatory threshold (these adjust very well to the characteristics of each patient: age, pathology they have, metabolic situation, and there is a strong link between the work load requested and the comfort shown by the patient), lactate, dyspnoea, visual analogical scale, among others[6].

In addition to the physiological perspective, the prescription should also be customised taking into account the associated pathologies presented in the patient, the medical treatment being followed, and the social-cultural and economic level.

Given the scientific evidence that links improvement to cardiovascular resistance with health benefits and a reduction of the cardiovascular risk factor in sedentary patients, the aim of this study is to assess whether or not an unsupervised customised physical exercise programme improves physical condition parameters, such as cardiovascular resistance - tolerance to exertion and some anthropometric variables - that could be used to improve cardiovascular and metabolic disorders presented in the patients, as well as enhancing their physical well being.

Material and method

Sample

The sample studied is made up of 119 patients moved from other services at the Sant Joan de Reus University Hospital to the Sports Medicine Unit at the same hospital. 44 subjects were excluded for not performing the physical exercise indicated or for not attending the final evaluation, with which the result assessment was performed using a total of 75 patients: 30 men and 45 women.

All the patients aged between 21 and 77 years old were visited in the Clinical Physiology consultancy of the Sports Medicine Unit, and as well as being sedentary (less than 30 minutes a day of regular exercise, less than 3 days a week), they had one or two of the following cardiovascular risk factors: excess weight, type 1 obesity, dyslipemia, type 2 diabetes mellitus, arterial hypertension, and they did not have any psychiatric illnesses, drug dependencies, oncological illnesses or diagnosed heart diseases.

Procedure

The calculation of the sample size was performed using the main variable, a 6-minute Test in which, with a minimum of 371 metres per participant, a better prognosis was obtained if the participant improved the distance by 40 metres. For this, the sample must include at least 35 participants[8-12].

Informed consent was requested from each patient to participate in the study voluntarily and in order to use their biomedical data.

This study was carried out in accordance with the Helsinki Declaration and the *International Conference of Harmonization* (ICH) Good Clinical Practices Guideline.

Before starting the exercise programme, a sports-medical examination was performed which included:

- H-Net Digitalised Clinical History: Anamnesis, exploration with apparatus, blood pressure reading and resting ECG.
- Anthropometric study with the measurement of weight, height, BMI, impedanceometry (percentage of fat [% of fat])[13].
- 6-minute Test following the procedures indicated in the scientific literature, in a marked walkway of over 30 metres[14-17]. The distance covered was measured. Before and after the test the following were assessed: blood pressure, heart rate, oxygen saturation, and after the test, perceived exertion (Borg scale)[18].

Throughout the 4-month long exercise programme, monthly reviews were arranged to assess adherence to the exercise programme and to motivate the participants, whilst checking that no significant medical problems had arisen.

On these visits, compliance with the indicated exercise programme was assessed by giving each patient a customised interview. In the case of failure by the patient to complete the prescribed exercise (not attaining the energy expenditure proposed on any of the weeks included in the assessment period), the patient was removed from the study.

Upon finishing the study, after the four months of physical exercise programme, the anthropometric study was repeated, as well as the 6-minute test using the same methodology.

Material

- Anthropometric: Anó-Sayol weighing scale and height rod (0-150 kilograms; precision of 100 grams and 55-200 centimetres, precision of 1 mm respectively). Impedanceometry: *body composition analyzer, type* BC-418 MA III (Tanita).
- 6-minute test: Riester blood pressure cuff. Casio stopwatch. Vital signs monitor *Suresigns VS3 Philips* (Pulse oximeter, heart rate). Analogical-visual scale.
- The 4-month Exercise Programme included: walking for 30 to 60 minutes each day in series of 10-15 minutes, exercise bike 3 days/week, 30 minutes/session with an intensity of 40-60% of the individual maximum functional capacity (reserve heart rate), isometric abdominals and static stretches. The aim was to increase the energy expenditure between 1,300 and 2,000 kilo-calories (Kcal) each week[19-21].
- To compare the evolution of the parameters of each sample, the data was handled via the "Student t" to compare the averages of the matching data. To compare the parameters in different samples (men vs. women); "Student t" to compare the unmatched data averages, and the two controls were checked using the Wilcoxon test for non-parametric matching data. The statistic package used was SPSS[19].

Results

The tables presented reveal the results of this work and are compared with results from a previous study performed in 2012 in our centre, using the same methodology and a sample with similar characteristics but on a smaller scale: 30 patients (14 men and 16 women). The objective of presenting them in this way is to assess the behaviour of the data studied upon increasing the sample size.

Table 1 reveals the demographic and anthropometric characteristics of the sample.

Tables 2 and 3 display the evolution of the values for weight, BMI, % of fat before and after the exercise programme with a slight reduction of these being statistically significant in the case of total weight and BMI.

Tables 4 and 5 respectively display the improvement in the distance covered (in metres), assessed using the 6-minute test and the evolution

Table 1. Sample characteristics (Averages ± Sd).

Year	2012 All n=30	2014 All n=75
Males	14	30
Females	16	45
Age (years)	48.5 ± 12.7	47.6 ± 13.3
Height (cm)	166 ± 6.97	166 ± 7.4
Weight (kg)	96.4 ± 21.8	100.6 ± 24.2
BMI (kg/m^3)	35.3 ± 8.27	36.6 ± 8.4
Fat (%)	38.3 ± 10.1	39.3 ± 10.3

Sd: standard deviation, cm: centimetres, kg: kilograms, BMI: Body mass index; %: percentage; m: metres.

Table 2. Evolution of anthropometric values. 2012 study ("student t" test comparison of averages, matched data).

Year 2012 (n=30)		Before	After	P
Weight (kg)	average	96.4	96.1	P = ns
	Sd	21.7	21.7	
BMI	average	35.3	34.8	P = ns
	Sd	8.3	7.9	
Fat (%)	average	38.3	37.4	P = ns
	Sd	10.1	10.1	

Weight in kilograms; BMI: Body Mass Index (kg/m^2); % fat: fat percentage; Sd: standard deviation.

Table 3. Evolution of anthropometric values. 2014 study ("student t" test comparison of averages, matched data).

Year 2014 (n=75)		Before	After	P
Weight (kg)	average	100.6	99.6	P <0.05
	Sd	24.3	23.3	
BMI	media	36.6	36.2	P <0.05
	Sd	8.5	8.1	
Fat (%)	media	39.3	38.9	P = ns
	Sd	10.3	10.2	

Weight in kilograms; BMI: Body Mass Index (kg/m^2); % fat: fat percentage; Sd: standard deviation.

Test 4. 6-minute test. Evolution of the distance and perceived exertion. 2012 study ("student t" test comparison of averages, matched data).

Year 2012 (n=30)		Before	After	P
Distance	average	471	505	P<0.001
	Sd	66.9	78.7	
Borg	average	3.8	2.9	P<0.002
	Sd	2.2	1.8	

Distance in metres; Sd: standard deviation; Borg: perceived exertion scale.

Table 5. 6-minute test. Evolution of the distance and perceived exertion. 2014 study ("student t" test comparison of averages, matched data).

Year 2014 (n=75)		Before	After	P
Distance	Average	474	514.6	P <0.001
	Sd	61	69.2	
Borg	Average	4.1	2.9	P <0.001
	Sd	2.4	1.8	

Distance in metres; Sd: standard deviation; Borg: perceived exertion scale.

of the perceived fatigue test assessed using a visual analogue scale. Both with statistical significance.

Via the indirect calculation of the maximum oxygen consumption (VO_2max), using the formulas from the 6-minute test, variations in metabolic equivalents were studied (METs) at the start and end of the exercise programme[14-17]: METs at the start (n=75): average of 5.2 (0.52) *versus* METs at the end: average of 5.55 (0.59). Increase: average of 0.35 (0.39) METs. Statistical significance p<0.001. No differences were found by sex.

The distances covered differentiated by sex were:

Women (n=45): start 471.2 (58.05) metres average *versus* 505.2 (64.14) metres average at the end. A difference of 34.02 (37.39) metres average, 7.22% increase in the distance covered. Statistical significance of p<0.001.

Men (n=30): start 478.1 (66.07) metres average *versus* 528.6 (75.15) metres average at the end. A difference of 50.47 (54.8) metres average, 10.55% increase in the distance covered. Statistical significance of p<0.001.

Overall, we can see that the anthropometric variables studied improve slightly: reduction in total weight (p<0.05), BMI (p<0.05) and % of fat, this latter without statistical significance. An increase occurs in the distance covered, with an average improvement of 40.6 metres p<0.001, with marked differences between men and women in the distances covered, though they are not statistically significant, and a reduction in the perceived exertion on the Borg Scale, average of 4.05 (2.37) to 2.93 (1.81) and a significance of p<0.001.

We can also observe an improvement in the physical condition expressed in METs, which despite being slight, is statistically significant.

Discussion

As in previous studies carried out in our centre on patients with similar characteristics, it has been observed that a large number of the subjects recruited for the study drop out - 44 subjects from a total of 119, some 37% of the initial sample. Given that this is a clinical study, it reflects the importance of patients adhering to a regular therapeutic physical exercise routine, and becomes a hugely significant problem to take into account[22].

In any case, this study revealed a lower number of drop outs compared to the 2012 study (45 subjects dropped out in 2012 - 60% of the total, whilst in this 2014 study, 44 subjects dropped out - 37% of the total), this figure may be due to the increase of controls performed (monthly) to ensure adherence over time to the exercise programme.

Therefore, it would seem plausible to deduce from the results obtained that undertaking monthly controls to review compliance with the exercise and to give motivational support will reduce the number of drop outs by 60%, or, likewise, increase adherence to the exercise programme planned for these patients by 40%.

A recent study undertaken in 2014 focuses on this aspect and proposes the use of the 6-minute test as a simple tool that can be used to improve the motivation of overweight patients[23].

The physical exercise programme proposed is intended to be easy to prescribe, without the need for complicated or complex complementary tests, easy for the targeted patients to follow, both in terms of the type of exercise to perform as well as their intensity (note that they are sedentary patients). It also aims to achieve a weekly calorie consumption increase of between 1,300 and 2,000 Kcal.

Scientific evidence acknowledges that physical condition is an excellent predictor of life expectancy and quality of life. Over recent years, numerous studies reveal an inverse association between physical condition and morbi-mortality in the population, very marked in patients with cardiovascular risk factors[24-29]. Improvements in both physical and mental health are observed: self-image, self-control, anxiety[30].

Physiological values such as maximum consumption of oxygen (VO_2max.), which can be estimated either directly or indirectly, constitutes an excellent marker of the maximum cardiovascular capacity[31,32], observing an almost linear relationship between the reduction of mortality and the increase of physical condition (METs). Therefore for each MET of improvement, there is a 12% increase in life expectancy in men and 17% in women[31,33,34].

These figures indicate that poor physical condition is an added risk factor, as well as a morbi-mortality predictor.

The 6-minute test fundamentally assesses endurance or cardiorespiratory resistance, i.e. tolerance to exertion, which is perhaps of greater interest in the patients used in this study, because it defines the aptitude that requires regular work at a sub-maximum percentage of the VO_2max.

From a functional perspective, the qualities of endurance (aerobic resistance) in patients are more useful than performance qualities, as they allow for a better adaptation to the energy demands of daily life. In any case, it should be noted that the VO_2max. measurement and the 6-minute test are complementary.

In this study, the initial distance covered in metres, average of 474 (61), is considerably lower than the values taken from literature regarding healthy people in the same age-range, average of 698 (96) metres. Even with the improvement that the patients displayed following the re-training period, the distance attained in metres - average of 514 (69), is still far removed from these values[35-37], though they are close to the theoretical benchmark distance considered as normal in patients, average of 531 (71) metres[9].

In the studies consulted, there are clear differences in the distances covered by men and women, with values that oscillate between 59-84 metres of difference in favour of men[35-37].

In this study, the initial distance covered is low and similar for men 478.1 (66) metres and women 471.2 (58) metres, whilst after the exercise period both subgroups improved, in particular men, with an average of 50.47 (55) metres, whilst women showed less improvement, with an average of 34 (37) metres.

Though both sexes reveal an improvement that is within the theoretical range considered optimum for patients: 31-75 metres[9,12], in women there should be a reinforcement of recommendations, motivation and follow-up. Note that these figures are from studies on pneumology patients and cannot therefore adjust completely to the characteristics of the sample studied, but they are the only ones that have been included, at least those that were accessible at this time.

There was also a slight yet significant improvement in the maximum METs calculated (increase of 0.35 (0.39) METS average). The figures show that both aerobic power (slightly) and endurance (in greater measure) would improve.

This increase of the aerobic power and endurance is reflected very clearly in the improvement of perceived exertion measured using the Borg Scale.

The improvement in the tolerance of the physical exertion-condition observed is not so clearly marked when analysing the anthropometric data, in which a considerably less notable improvement trend has been observed. Recent studies highlight that improving physical condition is more important for the health and for the reduction of cardiovascular risk than improving anthropometric values[28,29].

In this study, the abdominal girth measurement was not included - a measurement which in these particular patients, would quite possibly provide a better reflection of the modifications that occur to the intra-abdominal fat and body composition. In this respect it should be noted that the patients studied claimed that despite the minor change in their overall weight, they observed clear changes in the size of clothes they used and in particular around their waist.

Current studies reveal the prognostic value of the results obtained in the 6-minute test. Subjects that covered shorter distances have a greater risk of mortality across the board, in particular from cardiovascular illnesses, heart failure and dementia. The risk increases significantly when the distance covered is less than 400 metres, remaining high with distances of less than 460 metres. These authors promote the use of this test to assess the overall exercise capacity and to discover the evolution of cardiorespiratory aptitude following intervention programmes, as is the case in this study, and not only to assess the cardiovascular performance of heart and respiratory patients[38,39].

Thus, according to these studies, poor physical condition (measured using the 6-minute test), such as that revealed in the patients used in this study at the very beginning, is an added cardiovascular risk factor, as well as a morbi-mortality predictor.

Comparison of the data gathered in this study with that taken from the 2012 study reveals the same trend of improvement in the distance covered, perceived fatigue, total weight and BMI, but with greater strength upon increasing the sample. All of this reinforces the impression that it would be very interesting to implement a programme of these characteristics in a clinical-hospital environment, though clearly with necessary alterations.

The experience acquired over these years along with the data gathered and the bibliography consulted, lead us to consider that it is necessary to systematically include an evaluation of the physical condition and the prescription of physical exercise in the overall treatment of patients with cardiovascular risk factors, alongside clinical follow-up.

An assessment of physical condition is the foundation for the prescription of exercise and its developmental control. Clinical practice in sedentary patients with metabolic syndrome and cardiovascular risk factors should include: the 6-minute test to assess aerobic resistance and to calculate the VO_2max. indirectly, anthropometric measurements: weight, height, BMI, abdominal girth, as well as strength tests such as the hand dynamometer and/or isokinetic tests on the lower extremities.

Despite not being included in this study, strength is another related physiological variable, and seems to be a good morbi-mortality predictor and a reliable marker of the state of health. We therefore feel it should be included in the habitual assessment[40].

In terms of prescribing exercise to patients, the aim is to improve the physical condition qualities that are linked to the reduction of cardiovascular risk and morbi-mortality risk: VO_2max, tolerance to aerobic exertion-resistance, muscle strength[41,42].

We feel that there should be reference values for the distances achieved and possibilities for improvement in the 6-minute test in these patients. The findings discovered are aligned with this action.

Finally, negative effects should be avoided: dropping out, locomotive system injuries, increased cardiovascular and metabolic risk, for which the periodical supervision of these patients by medical specialists in clinical physiology is required.

In future studies the intention is to include: a abdominal girth measurement, a hand dynamometer reading, to increase the sample size, the re-training time and the supervision measures. Also include a control group and even ensure that the group is more homogeneous. However this latter factor is more difficult as it is a clinical study.

Conclusions

The inclusion of monthly controls, as well as the supervision and motivation measure, seem to increase adherence to the physical exercise programme in the study group.

The unsupervised customised physical exercise programme lasting for four months, proposed for the patients participating in the study (all of them sedentary patients with cardiovascular risk factors), has slightly improved their aerobic power (METs) and clearly improved their aerobic-tolerance resistance to exertion and their perceived fatigue. All these improvements are statistically significant.

The modifications detected in the anthropometric variables studied reveal discrete significant improvements to the weight and BMI.

As a result of these modifications, the cardiovascular risk reduces and the morbi-mortality and quality of life of these patients improves.

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Strength training in older athletes

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Summary

Aging is associated with a gradual and progressive mass loss function and muscle strength, called sarcopenia. This implies that the ability to perform activities of daily living decreases and also means an increased risk of falling and bone fracture.
Strength training can counteract deficiencies related to the progression of age due its ability to increase muscle mass and strength, even in advanced stages of life.
In older people, strength training improves cardiorespiratory fitness, muscle activity, body composition, mood, cognition, quality of life, among other benefits.
It is recommended multimodal training, including progressive strength training (EPF), traditional weightlifting training, and/or balance training, to reduce risk factors of suffering falls and fractures and to improve cognitive functions in healthy elderly, or those at risk to suffer from dementia. However, most authors recommend a combination of strength training and endurance, both healthy and frail subjects.
The recommended components of strength training are: a training period of 50-53 weeks, although the best is to keep it throughout life, with a frequency of three sessions per week, with a volume between two and three sets per exercise and between seven and nine repetitions per set with a load of 51 to 69% of 1RM,wotj a 120 seconds period of resting time between sets and 2.5 seconds between repetitions.
This review outlines how this type of training can improve the functional condition in elderly.

Key words:
Training. Force. Aging. Older. Athlete. Elderly.

El entrenamiento de fuerza en los deportistas mayores

Resumen

El envejecimiento se asocia a una pérdida gradual y progresiva de la masa, de la función y de la resistencia muscular, denominada sarcopenia. Esto implica que disminuye la capacidad de realizar las actividades de la vida diaria, y también significa un aumento del riesgo de caída y de fractura ósea.
El entrenamiento de fuerza puede contrarrestar las deficiencias relacionadas con la progresión de la edad por su capacidad para aumentar la masa y la fuerza musculares, incluso en edades avanzadas de la vida.
En las personas mayores, el entrenamiento de fuerza mejora la capacidad cardiorrespiratoria, la actividad muscular, la composición corporal, el estado de ánimo, la cognición, la calidad de vida, entre otros beneficios.
Se recomienda realizar entrenamiento multimodal, lo que incluye el entrenamiento de fuerza progresivo (EPF), el entrenamiento tradicional del levantamiento de peso, y/o el entrenamiento del equilibrio, para disminuir los factores de riesgo a sufrir las caídas y las fracturas y para mejorar las funciones cognitivas en los mayores sanos, o en los que están en riesgo a sufrir la demencia. No obstante, la mayor parte de autores recomiendan una combinación de entrenamiento de fuerza y de resistencia, tanto en sujetos sanos como frágiles.
Los componentes del entrenamiento de fuerza recomendables son un período de entrenamiento de 50-53 semanas, aunque lo mejor es continuarlo durante toda la vida, con una frecuencia de realización de tres sesiones por semana, con un volumen de dos-tres series por ejercicio con siete a nueve repeticiones por serie y todo ello realizado con una intensidad de carga del 51 al 69% de la 1RM, intercalando un periodo de reposo de 120 segundos entre las series y de 2,5 segundos entre las repeticiones.
La revisión expone las formas de este tipo de entrenamiento para mejorar la condición funcional de las personas mayores.

Palabras clave:
Entrenamiento. Fuerza. Envejecimiento. Deportista mayor. Tercera edad.

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Muscle function in older people

The natural ageing process is associated with the gradual and progressive loss of muscle mass, strength and resistance, known as sarcopenia, a process that is an inevitable consequence of ageing[1]. Recent studies suggest that mitochondrial dysfunction, a reduction of sensitivity to insulin, and a drop in resistance are related to physical inactivity and with the increase of adiposity, instead of just with ageing[2]. Various studies have revealed that regular exercise can normalise some aspects of mitochondrial dysfunction related to age, whilst improving muscle function, by encouraging the synthesis of myofibrillar proteins[2,3]. A balanced diet that contains the right amount of proteins is also effective in improving a reduction in muscle mass, muscle strength and its functional capacities related to age[4].

However, the combination of correct nutrition along with the regular performance of exercise is considered to be an optimum strategy for maintaining muscle function[5].

With age, the capacity for the human organism to perform everyday activities diminishes, largely due to the reduction of muscle mass, which has a significant effect on health[6]. This is related to the reduction of spinal motor neurons and the alterations of the muscular mechanical function (reduction in the maximum stimulation frequency and loss of elasticity) of the muscular fibres of the lower extremities (types I and II)[7].

Muscle strength reduces gradually from 30 to 50 years old. At 60 years old, this reduction speeds up by 15% and can reach 30% by 80 years old. The final consequence is a considerable alteration to balance and an increased risk of falling, with the possibility of suffering various fractures[8].

Training can counteract age-related strength deficiency[7]. The crucial factor in maintaining strength is the increase of muscle mass and this can be achieved with strength training (ST). Some authors recommend using multi-modal exercise programmes such as those recommended by the American College of Sports Medicine and the World Health Organisation, combining progressive strength training (PST), aerobic exercise, flexibility and balance training, performed with the aim of improving health[9], reducing risk factors of suffering falls and fractures[10], and improving cognitive functions in healthy older people. They can also be useful for people at risk of suffering from dementia.

Multi-modal programmes have better effects than those achieved using the components independently[11].

Strength training in older people

In older people, ST improves the cardio-respiratory capacity, muscle activity, body composition, mood, cognition and quality of life, and greater haemodynamic activity can be seen in MRI scans. In people affected by cerebrovascular accident, ST improves muscle strength, including the maximum voluntary strength[12], the function of the upper and lower limbs and performance in functional tests.

According to Cruickshank, *et al.*[13], the benefits on strength are clear after performing ST on individuals suffering from Parkinson's disease, and in lesser degree, on those with multiple sclerosis. There is also some evidence suggesting that ST has a positive effect on the progression of the illness and mobility in people with Parkinson's disease. In men, progressive strength training significantly restores the expression of steroideogenic enzymes that have reduced with age and levels of sex steroid hormones[14]. In older women, ST increases the strength of the respiratory muscles and other muscles in the body, as well as performance in the sitting to standing test[15]. In those affected by hypertension, it improves arterial pressure and hand grip strength, and these benefits are maintained over 14 weeks of not training[16]. According to Carneiro, *et al.*[17], ST increases the flexibility of different joint movements in older women, including an improvement in the frontal hip flex.

ST performed with the components indicated in Table 1 is effective in improving muscle morphology[12].

The training variables should not be the same for groups of healthy older people, for those with limited mobility or for frail people. Results are considered to be those obtained after 6 to 8 weeks of training, and the next stages are programmed in relation to the new MR. As well as hypertrophy, ST should improve the synchronisation of the motor units and training should be performed using increasing loads and reducing the repetitions per series[7].

ST may be performed using weights, sandbags, machines, elastic bands, and the muscles on the body or the weight of another person. The most suitable place for training is at the gym, but it can also be performed in the athlete's home, outside or in water. In water, the load is the weight of the water. According to Koch *et al.*[18], exercises performed in this environment improve cardiovascular performance, body composition, flexibility, balance and muscle strength.

Multi-modal exercise programmes

Gianoudis *et al.*[10] recommend the use of multi-modal exercise programmes that incorporate progressive strength training (PST), traditional weight lifting, and/or balance training to reduce the risk factors of falls and fractures, and to improve cognitive functions in healthy older people, or those at risk of suffering from dementia[11].

Table 1. Strength training components to improve muscle morphology[12].

- Training period: 50-53 weeks.
- Frequency: three sessions a week.
- Volume: two-three series a week, of seven to nine repetitions per series.
- Intensity: 51 to 69% of 1MR.
- Rest: a resting period of 120 seconds between the series and of 2.5 seconds between repetitions.

Table 2. Predictors/factors involved in postural instability during the dynamic activities[19].

- Capacity to generate strength from the ankle muscles.
- Weakness of flexors, of extensors, and of hip abductors.
- Reduction of the moment and the power of the flexors and the extensors of the knee, the dorsal flexors and the ankle plantar flexors.

Postural instability plays a considerable part in the risk of falling, and among the predictors or factors involved in postural instability during dynamic activities the factors described in Table 2 can be found[19].

Joshua *et al.*[19] assessed the effectiveness of a customised programme (PST) of progressive strength training with sandbags to improve balance, with various stability limits, in older non-frail people with balance deterioration, in comparison with traditional balance exercise (TBE) and a combination of both (COMBI). In terms of time, all the groups (PST, TBE and COMBI) revealed a significant improvement in balance stability limits over the 6 months of training. However, among the groups, the PST displayed more significant changes in scores than the TBE group.

On the other hand, the results of the study by Beurskens *et al.*[20] reveal that intense bilateral strength training and unilateral training can be used to improve balance, to increase the maximum production of isometric strength, and to improve the reduction of performance during bilateral muscle contractions in older people.

Power training in older people

Falls suffered by older people are a major problem for public health due to their high prevalence and the serious consequences they have. Approximately 95% of all hip fractures that occur each year are attributed to falls, and between 20-30% of those that fall and suffer a hip fracture die within 1 year.

Muscle strength and power are two important conditions in maintaining balance. Therefore, it has been suggested that the power of the lower extremities (the result of muscle strength through speed) may be more influential than strength when walking in the recovery of balance and to avoid falls, following an excessive postural alteration. In fact, people that suffer from falls have less muscle power in the lower limbs than those that do not fall.

Pamukoff *et al.*[21] ensure that strength training (ST) is more effective than power training (PT) in the recovery of balance with just one step, which is why they recommend ST in the treatment of balance in older people. An important objective for older people is remaining independent when performing everyday tasks. During ageing, muscle power reduces earlier and more quickly than strength. Power is related more intensely to functional state than strength[22]. As well as age, other alterations such as a reduction in voluntary neuromuscular activation cause modifications to the nervous system which reduces power. People over 80 years old can perform the explosive strength exercise at an intensity of between 75 and 80% of 1 MR[22]. The strength exercise with an intensity of around 60% of 1 MR, performed as quickly as possible (between 33 and 60% of the speed of the maximum movement without strength), can also improve power[22].

According to Rajan and Porter[22], even older people that attend rehabilitation programmes are capable of performing high-speed power training (PT).

Strength and resistance training (concurrent) in healthy and frail older people

Strength training is an effective intervention in improving muscle strength, power and muscle mass in healthy and frail older people[24]. Moreover, resistance training results in an improvement of the VO_2max and the sub-maximum resistance capacity of these people[25], and therefore a combination of strength and resistance training (concurrent training) for older people is the most effective way to improve neuromuscular and cardiorespiratory function.

Concurrent training performed at a moderate frequency (twice a week) may promote significant increases in muscular hypertrophy, in strength and in the power of older people. Strength training should be performed at moderate to high intensity (from 60-80% of 1MR) and at moderate volume (between 2 to 3 series per exercise). Furthermore, resistance training should be performed at moderate to high intensity (between 60-85% of VO_2max) and the volume should be moderate (between 25 and 40 minutes). For the concurrent training protocols, in which strength and resistance training are performed on the same day, the gains of strength and resistance may be optimised by performing the strength training before resistance training, in the sequence of the exercises within the session. Moreover, twice a week may be an optimum frequency to promote an increase in the muscle mass and strength, as well as to improve the cardio-respiratory aptitude in older people that have been previously trained with the concurrent.

In terms of improving the functional capacity of older people, the prescription of concurrent strength training and resistance training should include high-speed strength training, designed at improving muscle power, given that muscle power has been associated with functional capacity in older people.

As well as the positive effects of concurrent training on the functional capacity of healthy older people, another issue that should be

researched more thoroughly are the potential benefits of combining strength training with resistance training in the functional capacity of physically frail people, given that this intervention improves the general physical condition of this demographic by maintaining independence and preventing disability or other adverse outcomes.

Based on current knowledge, it would appear that interventions with exercises that include resistance training, strength training and muscle power training should be recommended to frail older people with the aim of improving their functional capacity. One important fact is that concurrent training performed on alternate days may optimise O_{2peak} adaptations (the consumption of sub-maximum oxygen) in both sexes, a fact that is possibly attributable to the prolonged recovery period (at least 24hrs) between subsequent training sessions[26].

According to Beurskens *et al.*[20], bilateral deficit (BLD) is a neurophysiological phenomenon that is characterised by a reduction of the capacity to generate strength during synchronised bilateral contractions, when compared to the sum of identical unilateral contractions. Intensive strength-resistance training (concurrent) increases the bilateral MIF (maximum isometric force production) and reduces BLD after training, due to its bilateral characteristics, whilst balance training increases unilateral MIF and the BLD, due to its predominantly unilateral nature in older people. As such, Beurskens *et al.*[20] suggest that intensive bilateral strength training, as well as unilateral training interventions in the exercise, to improve balance, can be used to increase the maximum production of isometric strength and to improve the reduction of performance during bilateral muscle contractions in older people.

Circuit training

Aside from the conventional strength training described, older people benefit from circuit training. As its name suggests, the circuit is nothing more than a series of stations - around 10 - and a specific type of exercise is performed at each.

Generally, the intensity of the exercises does not exceed 50% of 1 MR, though some participants reached 90% without displaying any significant alterations. In the first case, the number of repetitions is very high, around 15, which entails an effective load of around 30 seconds, the same time that should be spent resting between each of the exercises.

An essential requirement when organising the stations is to ensure that when one works a muscle group from the upper part of the body, the next station should work the muscles in the lower part of the body. Even though the order can and should be chosen by the athlete or the trainer, Table 3 presents a circuit training scheme.

A suitable load is around 75% of 1 MR, which is the load produced by the contraction of the muscles used that oppose the contraction of the target muscles. The complete lap around the circuit can be performed once or various times (up to four). In the latter case, a 3-6 minute rest is required before starting the next lap. The duration of this kind of circuit may vary between 20 to 30 minutes each day and there are numerous benefits obtained from performing it.

Table 3. Circuit training system.

- Neck muscles.
- Left branchial biceps.
- Right branchial biceps.
- Back muscles.
- Forearm muscles.
- Crural quadriceps.
- Deltoids and other shoulder muscles.
- Calf muscles.
- Major pectoral muscle.
- Abdominals.

According to Skidmore *et al.*[27], there are three kinds of circuit strength training: traditional (TCT), aerobic circuit strength training (ACST) and circuit strength training combined with interval training (CSTIT). TCT has the capacity of producing high levels of blood lactate (BL), heart rate (HR) and perceived exercise rate (PER), meaning its use can be recommended to individuals that perform recreational activities. For this reason it is advisable to include adequate resting periods within load sessions to reduce the risk of suffering from injuries resulting from their use or through an excess of training. CSTIT is a training method that allows more work to be done in less time, with the aim of achieving multiple physical components in one exercise session. Blood lactate (BL) can be a good indicator of the intensity of the exercise when comparing the different training protocols in the circuit. Habitual CSTIT training may lead to increases in strength and muscle resistance, and improvements to cardiovascular performance.

According to Elsisi *et al.*[28], circuit training (TCT) applied over 12 weeks in older women has beneficial effects by increasing bone density and mineral content.

Romero Arenas *et al.*[29] indicate that high intensity strength circuit training leads to larger muscle mass and bone mineral density in older people. These improvements are similar to those observed in traditional heavy-load training, with the advantage that circuit training with heavy loads requires less time than traditional strength training. Furthermore, only circuit training with heavy loads results in major adaptations in the cardiovascular system and in the body composition (reduction of fat mass)[29]. To optimise the prescription of circuit training with loads, it would be advisable to identify the most effective combination of intensity, volume, work resting ratio, the weekly frequency and the sequence of the exercise to promote neuromuscular and cardiorespiratory

Table 4. Guidelines for performing circuit training with loads[29].

- Perform at least 2 sessions a week, to which resistance training may be added (walking, jogging, running, etc.).
- The training load of each session should oscillate between 30 and 50 minutes.
- The intensity of the load, to promote hypertrophy, may vary between 60-85% of 1MR. To develop power, the load may be 40% of 1MR, performed at high speed one day a week.
- The rest period between each of the exercises should be 30 seconds.

adaptations, and those to the body composition of older people. These authors recommend performing circuit training with loads according to the guidelines in Table 4.

Other effects of circuit training

Circuit training (CT) reduces fat mass, the body mass index (BMI), plasma uric acid, total cholesterol, triglycerides and the nitrogen balance, and increases the metabolic equivalent (MET) and flexibility of overweight and obese women[30]. Likewise, it has been observed that a CT programme improves the symptoms of depression resulting from a stroke, by modifying branched chains amino acids (isoleucine, leucine and valine) and free tryptophan[31].

Administering vitamin D supplements along with circuit training performed for 12 weeks has positive effects upon the profiles of blood lipids and stomach fat in older women affected by type 2 diabetes and deficient in vitamin D[32]. According to the Shabani group[33], circuit strength training improves the levels of glycated haemoglobin (HbA1c) in the blood, for which it could be a recommended treatment for type 2 diabetes, and Fett *et al.*[30] indicate that the use of CT with aerobic exercise should be considered when it comes to treating obesity in women, though other authors such as Paoli *et al*.[34], consider that high-intensity circuit training is more effective in improving blood pressure, lipoproteins and triglycerides in middle-aged overweight women, than aerobic exercise alone or low-intensity circuit training.

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Effect of variable resistance on post-activation potentiation: a systematic review

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Summary

Introduction: The Variable Resistance (VR), as well as the Post-Activation Potentiation (PAP) have been used as training methodologies to improve the explosive strength in athletes. By the moment, there is no specific knowledge of the number of investigations connecting both variables that exist in the main data bases.
Objective: The aim of this study was to find out which were the VR methods used to generate PAP between January 2011 and January 2016. The secondary aim was to visualize the stimulus intensity and the variations in the explosive strength levels recounted in every one of the studies consulted for this research.
Method: the design is a systematic revision of the studies previously published that connected VR with PAP. The systematic research included articles published since January 2011 until January 2016 in the Web of Science (WOS), Scopus, Sport Discuss, PubMed, and Medline. For the studies selection, only those articles using VR as a training methodology to generate PAP were identified.
Results: Nine articles were identified, which were stratified according to the training performed: (i) Intra-Session Variable Resistance (n = 3), (ii) Intra-Repetition Variable Resistance (n = 1), and (iii) Intra-Set Variable Resistance (n = 5). On the other hand, eight out of nine studies were focused on the lower limbs and none of them focused specifically on the upper limbs. It was also observed that all those studies showing significant variation in explosive strength worked with over 80 % 1RM.
Conclusions: There is no conclusive evidence to identify the real effect of VR over PAP, and clearly not for the upper limbs. However, there are indicators that the Intra-Set Variable Resistance can generate acute changes in the explosive strength levels working over 80 % 1RM.

Key words:
Variable resistance.
Post activation potentiation,
Explosive strength.

Efecto de la resistencia variable sobre la potenciación post activación: una revisión sistemática

Resumen

Introducción: Tanto la Resistencia Variable (RV) como la Potenciación Post Activación (PAP) han sido utilizadas como metodologías de entrenamiento para mejorar la fuerza explosiva en deportistas, pero hasta el momento no se sabe cuántas investigaciones existen en las principales bases de datos que relacionen ambas variables.
Objetivo: Investigar cuáles fueron los métodos de RV utilizados para generar PAP entre enero de 2011 y enero de 2016. El objetivo secundario fue visualizar las intensidades de estimulación y los cambios en los niveles de fuerza explosiva reportados en cada uno de los estudios consultados.
Método: El diseño corresponde a una Revisión Sistemática de los estudios previamente publicados que relacionaron la RV con PAP. La búsqueda sistemática incluyó artículos publicados desde enero de 2011 a enero de 2016 en Web of Science (WOS), Scopus, Sport Discuss, PubMed y Medline. Para la selección de los estudios, se identificaron sólo aquellos artículos que usaron RV como metodología de entrenamiento para generar PAP.
Resultados: Se identificaron nueve artículos, los cuales fueron estratificados según el entrenamiento que realizaban: (i) Resistencia variable intra-sesión (n = 3), (ii) Resistencia variable intra-repetición (n =1) y (iii) Resistencia variable intra-serie (n = 5). Por otro lado, ocho de los nueve estudios consultados estuvieron centrados en los miembros inferiores y ninguno de forma específica en los miembros superiores. También se pudo observar, que todos aquellos estudios que reportaron cambios significativos en la fuerza explosiva trabajaron sobre el 80 % de 1RM.
Conclusiones: No existe evidencia suficiente para conocer el verdadero efecto de la RV sobre la PAP, más aún en los miembros superiores. Sin embargo, hay indicios que la resistencia variable intra-serie puede generar cambios agudos en los niveles de fuerza explosiva trabajando sobre un 80 % de 1RM.

Palabras clave:
Resistencia variable.
Potenciación post activación.
Fuerza explosiva.

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Introduction

Various training methods are used to improve explosive strength levels in athletes. These methods include plyometrics[1], contrast training[2], eccentric dynamic protocols[3], isometric loads[4], electro-stimulation[5], sports training methods that incorporate Variable Resistance (VR)[6-9], among others.

In terms of sport training based on VR, it is important to mention that the main feature of these training systems is the variation or change of intensity in the work session. Over recent years, it has been shown that this stimulation method has acquired a leading role in various lines of research[9-18]. Increases in the levels of explosive strength are attributed to the activation generated in the Central Nervous System by the change of intensity in the repetition, series or work session.

Some of the possible benefits of stimulation with VR protocols could be Post-Activation Potentiation (PAP); this training method corresponds to a transitory increase of muscle strength and power following a prior motor action[19]. PAP can be achieved through diverse forms of activation, among which are maximum voluntary contractions (MVC), also called post-tetanic potentiation[20]. Therefore, PAP would produce an increase in the explosive strength of athletes[19, 20].

The logical sequence for the generation of PAP via VR has three phases: The first corresponds to the assessment of unpotentiated physical capacity. The second corresponds to the application of a stimulus that triggers the potentiation (in this phase it can be activated with VR). While in the third phase the physical capacity measured in Phase 1 is assessed again, but now in a potentiated state.

Hirayama (2014)[14], with the aim of achieving PAP in study subjects, used VR stimulation as an activation method. The researcher concluded that VR is a good alternative to acutely increase levels of explosive strength. However, there is little evidence to link the different VR methods with PAP, both for lower and upper limbs. The main aim of this systematic review was to research which were the variable resistance methods used to generate PAP between January 2011 and January 2016. As a secondary objective, the stimulation intensities were analysed, as well as changes in the explosive strength levels reported in each of the studies consulted.

Method

Literary search

To develop this systematic review, an exhaustive literary search was performed both manually and electronically. To do this, different combinations of the key words displayed in Table 1 were used. The electronic search identified articles published in the *Web of Science (WOS), Scopus, Sport Discuss, PubMed* and *Medline*.

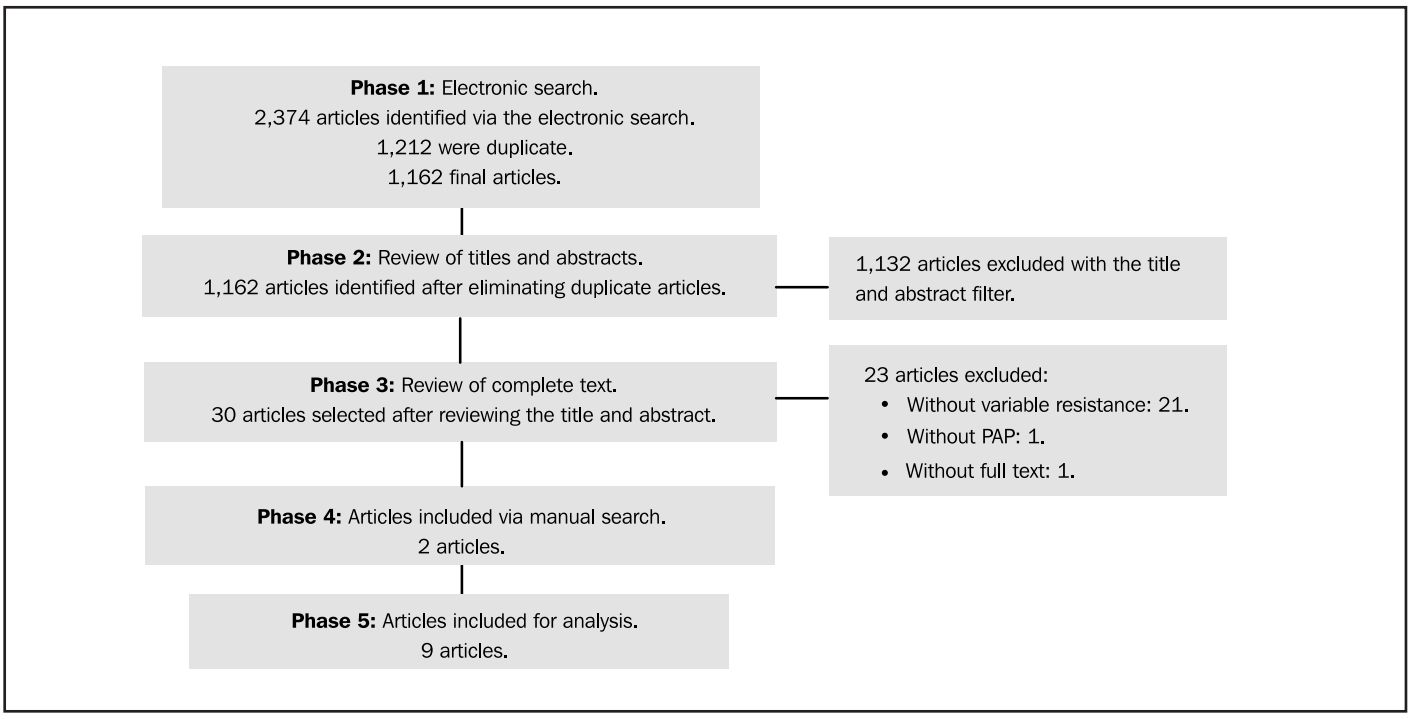
The search strategy was divided into five phases (Figure 1). The first phase was an electronic search in the different databases. All the duplicates were eliminated in this phase of the search; a total of 1,162 articles were identified for the title and abstract filter. Phase two consisted in a review of all the titles and abstracts of the articles that could be included in the review; at the end of this phase, 30 articles remained. In phase three, the complete articles were read, thus identifying the final articles to be included in the analysis. After reading the complete articles, 23 studies were eliminated, 21 as they did not use variable resistance as an activation method, one because it did not relate the variable resistance used in the study to PAP, and one given the impossible nature of achieving the complete text. Phase four consisted in adding the articles found in the manual search. The references of the articles added were reviewed with the possibility of identifying new studies. At this stage two studies were included. Furthermore, independent reviewers agreed upon the 9 articles included for analysis.

Table 1. Search strategy using a selection and combination of key words.

Steps	Strategy	WOS*	Scopus	Sport Discuss	PubMed	Medline
1	post-activation potentiation	73	39	42	36	27
2	potentiation muscle	491	1.079	21	396	340
3	activation muscle	19.078	18.512	1.166	17.821	13.838
4	#1 OR #2 OR #3	19.413	19.348	1.219	18.133	14.082
5	complex training	8.832	7.045	97	14.906	5.066
6	contrast training	4.637	3.135	40	7.688	2.995
7	strength training	8.325	8.507	2.259	10.725	6.925
8	resistance training	6.046	7.117	2.010	6.452	5.597
9	#5 OR # 6 OR #7 OR # 8	24.355	21.701	3.743	32.228	17.299
10	#4 AND #9	692	539	138	568	437

*WOS (Web of Science).

Figure 1. Identification of studies in the systematic review.



Inclusion and exclusion criteria

The search limits were: articles published in the last five years (January 2011 to January 2016), written in English, Portuguese, French or Spanish and in the field of study or other criteria regarding the database.

The importance of each study was assessed in accordance with the inclusion criteria established in Table 2. The studies that did not meet the inclusion criteria were excluded. The discrepancies found were resolved through consensus of the researchers.

Assessment of the methodological quality

The Newcastle-Ottawa Scale (NOS) was used to assess the quality of the studies. Classification was performed based on three criteria: selection (maximum four stars), comparability (maximum two stars) and results (maximum three stars). Articles graded between seven and nine were considered to be of *high* methodological quality, from four to six *moderate* and below four *low*.

Table 2. Inclusion criteria.

Study design	Experimental
Demography	Healthy adult male athletes (trained-not trained)
Intervention	Strength training that combines loads and produces reinforcement (acute or chronic)
Comparator	The increase of PAP generates an increase in strength
Results	Positive and negative

Results

Amount of results available

The search was performed electronically and manually. 2,374 articles were identified, of which 1,212 duplicates were eliminated, leaving 1,162 articles filtered for inclusion. The titles and abstracts were assessed depending on their relevance for systematic review, resulting in 30 articles. The complete texts for 29 bibliographic references were obtained. After applying the inclusion criteria to the full texts of these documents, 23 articles were excluded. After performing a manual search, two studies were included, leaving a final total of 9 articles to analyse.

In terms of the grading obtained by the articles according to the NOS, one study obtained a moderate grading whilst the remaining eight received a high quality grading, seven of these achieving the maximum quality (Table 3).

Variable resistance

Even though PAP can be generated in any muscle group[20], the application methods of VR are very wide. In this respect, the research reviewed allowed for the observation of different intervention styles

Table 3. List of articles included with grading according to the *Newcastle-Otawa Scale* (NOS).

	Selection	Comparability	Results	Total
Chiu & Salem[11]	***		***	6
Crum *et al.*[12]	****	**	***	9
Fukutani *et al.*[13]	***	*	***	7
García-Pinillos *et al.*[7]	****	**	***	9
Hirayama *et al.*[14]	****	**	***	9
Miarka *et al.*[15]	****	**	***	9
Nacleiro *et al.*[16]	****	**	***	9
Okuno *et al.*[17]	****	**	***	9
Wyland *et al.*[18]	****	**	***	9

in various sporting modes. This diversity of VR application methods to generate PAP meant that the comparison and synthesis of the results were more complex. With the aim of organising the information and meeting the aim of this review, the studies were divided into three categories based on the variable resistance methods: (i) Intra-session variable resistance (n = 3), (ii) intra-repetition variable resistance (n = 1) and (iii) intra-series variable resistance (n = 5) (Table 4).

Next, and following a thorough systematic review of the past five years, only the studies that linked some of the variable resistance methods (Intra-Session, Intra-Series, Intra-Repetition) to PAP were displayed:

Intra-session variable resistance

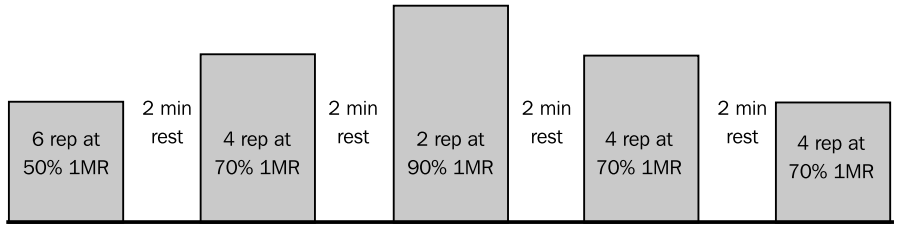
This kind of variable resistance consists in changing the intensity of the loads within the session, i.e. the training series should increase or reduce the intensity of the work. This training method may overlap with the *Contrast Method*, as the structure is very similar, however the central difference is that the *Contrast Method* always has heavy loads and then a motor action (physical test or sporting test), whilst the *intra-session variable resistance* method changes the intensity of the load randomly, depending on how the trainer programmes the training session. It is also important to mention that, in translations in English, the terms *"Contrast Training"* or *"Complex Training"* are used. For this reason, and so as not to make mistakes in the application of the training sessions, the precise methodology used should be identified (Figure 2).

García-Pinillo *et al.* (2014)[7], developed a 12-week training programme, in which the study used intra-session variable resistance. During the first week of intervention, the training sessions combined the isometric half squat (40-second contraction), plus jumps from a sitting position in the same session. During the second week of intervention, the training sessions combined the isometric half squat (60-second contraction), plus jumps alternating the right lower extremity and the left within the same session. In the following weeks, the isometric contraction times were varied, as were the amount of series and jumps. However, the rest time between the series was always two minutes. Upon finishing the study, the researchers reported significant changes in the explosive strength assessed via the CMJ only for the test group ($p<0.001$); likewise, in the same study changes were reported in the Balsom test and in the ball kicking speed test. Along the same lines of stimulation, Hirayama (2014)[14] stimulated with increasing loads using the Squat method, finishing with maximum isometric contractions in the same exercise, whilst the control parameter was the evaluation of explosive strength via the CMJ test (the assessments were performed at the end of each load). Upon finishing the study, the researchers reported changes in explosive strength from 60% of 1MR (60% of 1MR - 80% of 1MR and IMC $p<0.05$). In a study presented by Okuno *et al.* (2013)[17], the loads were increased within the session in the following way: 1 x 5 to 50% 1MR + 1 x 3 to 70% 1MR + 5 x 1 to 90% 1MR, whilst the control parameter was the *Repeated Sprint Ability* (RSA) test. Upon finishing the study, the researchers reported significant differences in the best time and average time in the RSA test only for the test group ($p<0.01$).

Intra-series variable resistance

This kind of variable resistance consists in changing the intensity of the loads within the session, i.e. during the development of the training series the intensity of the work should be increased or reduced every certain number of repetitions. This training method can be carried out

Figure 2. Example of intra-session variable resistance.



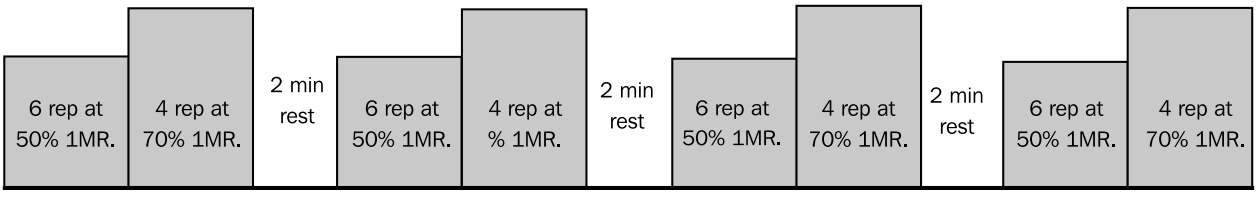
Rep (repetition); % (percent); 1MR (one maximum repetition); min (minutes).

Table 4. Characteristics of the publications that relate variable resistance to PAP.

Authors	Year	Resistance type	Treatment	Results
Chiu y Salem[11]	2012	Intra-Series	a) 2 x 4 start-ups (70-80-90-100% of 1MR). Control parameters: CMJ (before, during and at the end of the session).	Significant differences (p<0.05) in CMJ from the base line and the middle measurement. Significant differences (p<0.05) in CMJ from the base line and the final measurement.
Crum, *et al*.[12]	2012	Intra-Series	a) Control. b)1 x 30- 1 x 40- 3 x 50% of 1MR in Squat. c)1 x 30- 1 x 40- 3 x 65% of 1MR in Squat. Control parameters: CMJ one minute before each condition; CMJ 0.5, 3, 5, 10 and 15 minutes of each condition.	There were no significant differences in CMJ in any of the conditions (p<0.05).
Fukutani, *et al*.[32]	2104	Intra-Series	a) Weight condition: 1 x 45- 1 x 60- 3 x 75- 3 x 90% of 1MR in Squat. b) Moderate conditions: 1 x 45- 1 x 60- 3 x 75% of 1MR in Squat. Control parameters: 3CMJ before and after both conditions.	In both conditions significant increases were recorded in CMJ (p>0.05).
García-Pinillos, *et al*.[7]	2014	Intra-Session	a) Isometrics + plyometrics without external loads. b) Control. Control parameters: CMJ, Speed in 5, 10, 20 and 30m, agility test and kicking speed test.	Significant changes were observed in the CMJ, Balsom test and ball kicking speed (p<0.001) were only observed in the test group. There was a significant difference for both groups in 5, 10, 20 and 30m (p<0.05).
Hirayama, *et al*.[14]	2014	Intra-Session	a) 1 x 20- 1 x 40- 1 x 60- 1 x 80% 1MR-1 CMI in ½ Squat. b) Control. Control parameters: CMJ after each execution.	Significant differences were observed in CMJ after the application of loads with: 60% of 1MR, 80% of 1MR and CMI (p<0.05).
Miarka, *et al*.[15]	2011	Intra-Series	a) Special Judo Fitness Test (SJFT). b) Plyometrics + SJFT. c) Maximum strength + SJFT d) Contrast exercise + SJFT.	Significant differences were found in the number of throws during condition "b" (plyometrics) when compared to the Control (p<0.05).
Nacleiro, *et al*.[16]	2014	Intra-Series	a) 1 x 80% de 1MR in ½ Squat without vibration. b) 1 x 80% de 1MR in ½ Squat with vibration. c) Control. Control parameters: 3 CMJ and one DJ (optimum falling height).	Significant increases in CMJ after 4 min of recovery (p<0.05). Significant increases with the low volume protocol, regardless of the (p<0.015). Significant increases in DJ with the protocol.
Okuno, *et al.*[17]	2013	Intra-Session	a) 1 x 5 to 50% of 1MR + 1 x 3 to 70% of 1MR + 5x 1 to 90% of 1MR. b) Control. Control parameters: RSA test (6 x 30m).	Significant differences in the best time and average time of RSA only for the test group (p<0.01).
Wyland, *et al*.[18]	2015	Intra-Repetition	a) Control: Sit & Rest test for 5 min. b) 5 x 3 to 85% of 1MR + isometrics in Squat. c) 5 x 3 to 85% of 1MR + 30% additional load via an elastic band. Control parameter: 10-yard test (9.1m).	Significant reduction in the 9.1m test (p=0.002) at 4 min of rest.

IMC (Isometric Maximum Contraction); 1MR (One Maximum Repetition); BW (Body Weight); SJ (Squat Jump); CMJ (Counter Move Jump); AB (Abalakov); DJ (Drop Jump); SJFT (Special Judo Fitness Test).

Figure 3. Example of intra-series variable resistance.



Rep (repetition); % (percent); 1MR (one maximum repetition); min (minutes).

in two ways: The first can be performed using electronic devices that enable the resistance to be varied every certain number of repetitions in a programmed way, whilst the second is manually - a method that requires trainers and/or assistants to change the load. The second action is just as precise as the use of electronic devices, but it is less efficient (Figure 3).

With regards to this form of stimulation, some authors have reported the following: Chiu and Salem (2012)[11] demonstrated significant changes in explosive strength assessed via the CMJ ($p < 0.05$). These researchers applied two series of four increasing start-up repetitions (80 - 80 - 90 - 100% of 1MR). However, Crum *et al*. (2012)[12], using two increasing Squat methods (a: 1 x 30 – 1 x 40 – 3 x 50% of 1MR in Squat. b: 1 x 30 – 1 x 40 – 3 x 65 % of 1MR in Squat), did not report significant changes in any of the conditions ($p > 0.05$).

In another research study, Fukutani *et al.* (2014)[13] applied two increasing training methods using Squats (a: 1 x 45 – 1 x 60 – 3 x 75 – 3x 90% of 1MR. b: 1 x 45 – 1 x 60 – 3 x 75% of 1MR), whilst the control parameter to assess explosive strength was the CMJ (this assessment was performed before and after applying the protocols). Upon finishing the study, the researchers reported significant increases in explosive strength with both methodologies ($p=0.05$). Another study that aimed to trigger PAP was that presented by Miarka *et al*. (2011)[15]; these researchers applied three treatments (Table 4), whilst the control parameter was a special judo fitness test (SJFT). Upon finishing the research, the authors reported a significant increase in the amount of throws following the application of a plyometric protocol ($p < 0.05$), the specific characteristic of this method was the increase in the height of the bars over the series (10 x 3 jumps 20 - 40 - 60 cm with 30s rest).

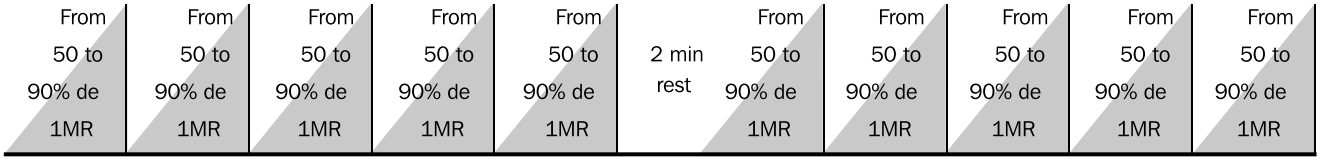
Another methodology used to trigger PAP has been to combine strength exercise with vibration. In this respect, Nacleiro *et al*. (2014)[16] compared two Squat protocols with and without vibration in the final phase of the series. These researchers used the CMJ and *Drop Jump* (DJ) as the control parameter. Upon finishing the study, the researchers reported the following: significant increases in CMJ after 4 min of recovery ($p<0.05$), significant increases in *Drop Jump* (DJ) with the vibration protocol after 1 min of recovery ($p=0.015$).

Intra-repetition variable resistance

This kind of variable resistance consists in changing the intensity of the loads within the repetition, i.e. the training repetitions should increase or reduce the intensity of the work. This training method can be carried out in three ways: with elastic bands, with chains and/or electronic devices that allow the resistance to be varied in a programmed and precise way (Figure 4).

Also, in the PAP search, overloads were used with elastic bands. In this respect, Wyland *et al.* (2015)[18] applied three experimental conditions. The first, defined as "control", consisted in the application of the Sit &

Figure 4. Example of intra-repetition variable resistance.



Work with elastic bands:
2x5 of a 50 to 90% of 1MR with 2 minute break between series.

Rep (repetition); % (percent); 1MR (one maximum repetition); min (minutes).

Rest test for 5 min. The second protocol had 5 series of 3 repetitions at 85% of 1MR plus an isometric load. The third treatment included 5 series of 3 repetitions at 85% of 1MR with an additional load of 30% via an elastic band. The control parameter was the 10-yard test (9.1m). Upon finishing the study, the researchers reported a significant reduction in the 10-yard test (p=0.002) after 4 min of rest.

Discussion

Type of variable resistance: the main aim of this review was to research the variable resistance methods used to generate PAP. With regards to this objective, it was observed that the vast majority of the articles found stimulated intra-series variable resistance to generate PAP[11-13,15,16]; secondly, intra-session variable resistance training session were discovered[7,14,17]; and finally, intra-repetition variable resistance treatments were found in one study18. Despite the treatments that relate VR with PAP being divisible into three categories, the amount of existing studies in the majority of databases is low. This low number of studies is possibly due to the complexity of both variables. The aforementioned has been particularly notable over the past five years - the period in which serious scientific studies that address these training methods have been developed. To this it should be added that varying resistances, whether in the session, in the series and/or in the repetition, is not very effective, requires time, creates poorly controlled rests or considerably increases costs. This last point refers to the use of electronic devices that modify loads automatically.

Study duration: in seven of the nine studies consulted, the acute effect of VR on explosive strength was established, i.e. if the activation methods based on VR lead to PAP in the study participants within the training session. The remaining two studies focused on the chronic effects, i.e. long-term neuromuscular adaptations caused by the VR[7,16]. It is also important to analyse that once the systematic review has been performed no research studies relating VR with PAP were found for the upper limbs. Therefore, and regardless of the VR methods used, this is one of the alternative methodologies for future studies seeking to develop explosive strength. The aforementioned is due to the fact that in all the sporting activities observed, the lower extremities are largely those responsible for sporting performance, just as PAP was looked for in footballers[7], weight-lifters[13], weight lifters[14], judo players[15], athletes[16] and handball players[17]. In these sports, even more so in those that are defined by the body weight of the subjects, increases in muscle power levels must be achieved without considerably increasing muscle mass; for this reason, the movements should be executed with as much speed as possible, thus the athletes will be able to recruit type II fibres based on the speed of movement[21,22].

Stimulation intensities: with regards to the secondary aim of this review, it could be observed that all the treatments that used intensities of around 75% of 1MR obtained significant increases in explosive strength[11,12,16]. The aforementioned is based on the recruitment of type II fibres, as these kinds of fibres are the most likely to generate PAP[22]. Conversely, in studies that used intensities lower than 70% of 1MR, no increases were seen in explosive strength[12]. This last kind of stimuli have two favourable conditions for generating PAP; on the one hand, low intensity helps dissipate fatigue quicker, and on the other hand, it also enables the recruitment of type II fibres, whenever the movement speeds are high.

In accordance with the literary review performed, there are no intra-series variable resistance protocols in power zones (0.6 to 0.9 m/s of vertical bar speed)[23] that trigger PAP and that have made significant changes to explosive strength. As a result of the aforementioned, there is a need to understand the behaviour of explosive strength in power zones, and how this strength increases as a result of PAP of the muscles involved in the movement.

Conclusions

- VR is a field with little scientific evidence in terms of experimental works to generate PAP acutely in sporting performance.
- There are indications that VR training triggers PAP acutely in the lower limbs, whilst research on the upper limbs is practically non-existent.
- Therefore, more research is required in the relevance that VR has in sporting performance.

Practical applications

From a practical point of view, working with *variable resistance* is a good alternative to increase explosive strength levels in the lower extremities, though the following aspects should be taken into consideration:

- To trigger PAP in sports with predominant explosive strength, loads of around 80% of 1MR should be stimulated, in order to stimulate Type II Fibres.
- If the aim is to work with *intra-repetition variable resistance exercises* to trigger PAP, there should be some kind of device available that enables the precise quantification of the training load, as the use of elastic bands and/or chains makes it harder to control the training intensity.
- If devices that control and/or quantify the training intensities are not available, it is advisable to use *intra-series variable resistance exercises,* or *intra-session variable resistance exercises,* as these kinds of stimuli are easier to control.
- Finally, researchers and trainers are encouraged to continue to try out VR protocols, preferably in power zones (0.6 to 0.9m/s of vertical bar velocity).

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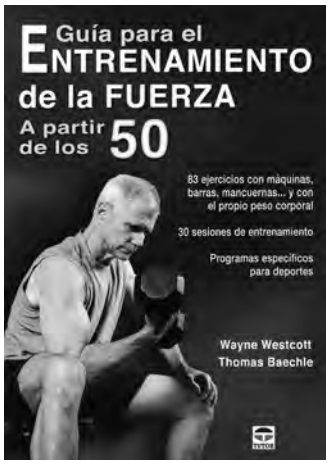

GUÍA PARA EL ENTRENAMIENTO DE LA FUERZA A PARTIR DE LOS 50

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Esta obra ofrece muchos beneficios a los adultos activos, incluyendo la mejora del rendimiento deportivo, la reducción del riesgo de enfermedades y la disminución de los síntomas de la artritis, la diabetes y la osteoporosis. Busca fomentar el aumento de la fuerza para mejorar la salud, el aspecto físico y el rendimiento.

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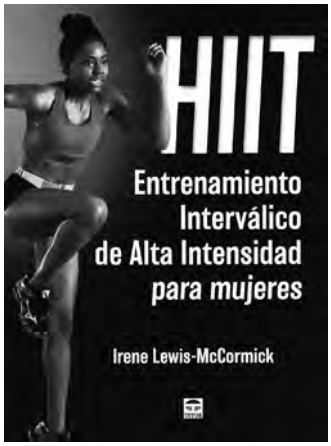

HITT. ENTRENAMIENTO INTERVÁLICO DE ALTA INTENSIDAD PARA MUJERES

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HIIT Entrenamiento interválico de alta intensidad para mujeres es el recurso que contiene la información de mayor fundamento científico, organizada y sistemática de la que se dispone sobre entrenamiento interválico de alta intensidad.

Este libro incluye ejercicios, combinaciones y progresiones específicos para quemar grasa, moldear y fortalecer el tren superior e inferior y aumentar la fuerza de la zona media (core) para lograr una postura excelente y una mejora del rendimiento en los ejercicios… y todo ello escrito teniendo presente el físico que toda mujer quiere tener.

LAS CUALIDADES FÍSICAS EN EL TENIS Y SU ENTRENAMIENTO

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Madrid, 2016. 288 páginas. P.V.P: 25 euros

Este libro es un manual resultado de años de investigación, mezclado con la experiencia docente de los autores y un análisis crítico. Ofrece a los jugadores, entrenadores, padres y aficionados los conocimientos teóricos y prácticos necesarios para la preparación física de jugadores de todas las edades y niveles.

Para ello, los autores profundizan en el estudio de las cualidades físicas requeridas en el tenis: resistencia (anaeróbica y aeróbica), fuerza (para desplazarse y para golpear), velocidad (tanto de desplazamiento como para reaccionar), capacidades coordinativas (para ajustar todos los complejos procesos de los golpes en un tiempo muy reducido) y movilidad articular (flexibilidad y elasticidad necesaria para los desplazamientos y golpeos en posiciones forzadas).

Además, ofrecen test de valoración de estas cualidades para jugadores de tenis, así como ejercicios y ejemplos de planificación para su entrenamiento.

¿A cuántos estímulos responde tu corazón?

Vichy Catalán se preocupa por tu salud e investiga sobre el metabolismo del colesterol.

Te quiere

www.vichycatalan.es

El papel de Vichy Catalán en la reposición de líquidos y minerales

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Para el buen funcionamiento del organismo no solamente es necesario un aporte equilibrado de nutrientes sino que el agua y los minerales son indispensables para llevar a cabo cada una de las funciones del cuerpo humano. El agua es fundamental para la regulación de la homeostasis, actúa como solvente de nutrientes y facilita su transporte, participa en la termorregulación corporal, mantiene el pH y la osmolaridad de la sangre y forma parte de la estructura de las células.

La cantidad de agua en el organismo disminuye a medida que pasan los años, de modo que un bebé puede tener hasta un 70% de agua y una persona anciana un 55%.

Pero el agua nos aporta también una cantidad necesaria de minerales y electrolitos muy importantes para diferentes funciones. El agua mineromedicinal Vichy Catalán tiene la misma osmolaridad que el plasma sanguíneo y de este modo favorece la absorción de todos los minerales que contiene.

Si bien en una dieta equilibrada la ingesta de minerales es suficiente, pueden ocurrir diferentes situaciones en que se puede producir una pérdida excesiva de éstos pudiendo llegar a ser perjudicial para la salud. Por este motivo la reposición de minerales debe tenerse en cuenta en aquellas situaciones concretas como haber sufrido una diarrea, vómitos o haber sudado en exceso.

Consideramos una diarrea cuando las heces son blandas y las deposiciones se producen en más de 3 ocasiones al día. La diarrea se puede producir por causas motoras, es decir, por una hiperactividad del tránsito intestinal causado por ejemplo por un estado de nervios, por una infección bacteriana o vírica que afecte al sistema digestivo (por ejemplo, una infección por *salmonella, Campylobacter* o rotavirus) o como efecto secundario al uso de antibióticos.

Independientemente de la causa, lo más importante es evitar una deshidratación provocada por la eliminación excesiva de agua y electrolitos junto con las heces, por lo que lo más aconsejable es la ingesta no solamente de agua sino también de estos electrolitos perdidos. Para ello, y al ser el agua de Vichy Catalán isotónica, permite una correcta ingesta de agua y la reposición de los electrolitos expulsados tales como sodio, potasio, cloruros y bicarbonato que favorecerán una correcta recuperación.

Otra pérdida importante de agua y electrolitos se produce con los vómitos, si éstos están causados, como en la diarrea, por agentes infecciosos, se debe tratar la infección y evitar la deshidratación. Pero también es habitual la aparición de alteraciones hidroelectrolíticas en aquellas personas con trastornos de la conducta alimentaria tales como anorexia o bulimia que recurren al vómito de forma habitual como medida compensatoria a la ingesta alimentaria. Estas personas deberían intentar mantener una adecuada ingesta de agua y electrolitos para evitar las consecuencias de estas alteraciones, sobre todo a nivel cardíaco.

En el caso de la sudoración excesiva ya sea en individuos que practican deporte o individuos que trabajan al aire libre o en oleadas de calor, se pierde una cantidad importante de agua pero también sales minerales que deberán reponerse mediante la ingesta de una bebida isotónica con un contenido de sales minerales igual que el plasma sanguíneo. En este caso, el agua Vichy Catalán aporta en estas situaciones la hidratación necesaria, así como una reposición de minerales adecuada por contener una cantidad de bicarbonato sódico, potasio, magnesio y otros minerales que actúan favoreciendo una adecuada recuperación. Por lo que su ingesta después del ejercicio, el trabajo o la exposición a elevadas temperaturas, evita indicios de deshidratación, supone una rápida recuperación de los líquidos perdidos mediante el sudor, y ayuda a una mejor recuperación a nivel muscular.

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2016		
VI Congreso mundial del deporte escolar, educación física y psicomotricidad	3-5 Noviembre La Coruña	web: www.sportis.es
Congreso Nacional de Medicina y CC aplicadas al Deporte	3-5 Noviembre Monterrey, NL (México)	E-mail: congresoamdyrnl2015@gmail.com web: http://cidcs.uanl.mx/
IV Congreso conjunto SEROD-AEA	9-12 Noviembre Bilbao	E-mail: e.torres@torrespardo.com web: www.torrespardo.com
Congreso Uruguayo de Ortopedia y Traumatología	10-12 Noviembre Montevideo (Uruguay)	web: http://www.sotu.org.uy
The European Workshop on Clinical Pediatric Exercise Testing (EWCPET 2016)	11-12 Noviembre Utrecht (Países Bajos)	web: www.juliusacademy.nl
IV Congreso Internacional de Psicología y Fútbol	11-12 Noviembre Montevideo (Uruguay)	web: www.supde.org/
World Congress of Performance Analysis of Sport XI	16-18 Noviembre Alicante	web: http://wcpas11.uafg.es/
XV Simposio Internacional: Avances y actualizaciones en Traumatología y Ortopedia"	17-19 Noviembre Madrid	web: http://goo.gl/mvhbT2
XVI Congreso Nacional de la Sdad. Española de Medicina del Deporte (SEMED-FEMEDE)	23-26 Noviembre Granada	E-mail: femede@femede.es web: www.femede.es
XV Congreso de la SEMAM (Sdad. Española de Medicina y Auxilio en Montaña)	24-27 Noviembre Granada	web: www.semamweb.com/
XIII Congreso de la Sociedad Portuguesa de Med. del Deporte	25-26 Noviembre Setúbal (Portugal)	web: http://www.spmd.pt/
British Association of Sport and Exercise Sciences Conference	29-30 Noviembre Nottingham (Reino Unido)	web: www.basesconference.co.uk/index.html
XXXV Congreso de la Fed. Italiana de Medicina del Deporte	30 Noviembre - 2 Diciembre Roma (Italia)	web: http://www.fmsi.it/
World Congress of Tennis Medicine & Performance	2-4 Diciembre Amelia Island, FL (EEUU)	web: www.stmsconference.com/
SEMS Medico-Legal and Anti-Doping Meeting	9 Diciembre Londres (Reino Unido)	E-mail: barryghill@hotmail.com web: www.basem.co.uk
2017		
International Conference on Physical Education and Sports Science	5-7 Enero Jaipur (India)	veb: www.icpess17.com
30th International ACHPER Conference	16-18 Enero Camberra (Australia)	web: www.achper.org.au/professionallearning/2017-achper-international-conference

2017 Sports Science Summit	24-27 Enero Londres (Reino Unido)	web: www.lifescienceevents.com
X Curso de Medicina y Traumatología del Deporte: "deportista veterano"	17-18 Febrero Toledo	E-mail: medicinadeporte2017@gmail.com
XXV Jornadas Nacionales de Traumatología del Deporte y IV Internacionales de Prevención de Lesiones en el Deporte: "prevención en el deportista en crecimiento"	2-4 Marzo Guadalupe (Murcia)	web: http://congresolesiones.ucam.edu/
Tackling Doping in Sport 2017	8-9 Marzo Londres (Reino Unido)	web: www.cecileparkconferences.com/?q=tackling-doping-sport-2017
IOC World Conference on Prevention of Injury & Illness in sport	16-18 Marzo Mónaco (Ppdo. Mónaco)	web: http://www.ioc-preventionconference.org/
World Congress on Osteoporosis, Osteoarthritis and Musculoskeletal Diseases	23-26 Marzo Florencia (Italia)	web: www.wco-iof-esceo.org/
11º Congreso Mundial de la Sociedad Internacional de Medicina Física y Rehabilitación	30 Abril-4 Mayo Buenos Aires	web: http://www.isprm2017.com/
XXVI International Conference on Traumatology: The Future of Football Medicine	13-15 Mayo Barcelona	web: www.isokinetic.com www.footballmedicinestrategies.com
55 Congreso de la Sdad. Española de Rehabilitación y Medicina Física	17-20 Mayo Pamplona	web: www.sermef.es
18th World Congress of the International Association of Physical Education and Sport for Girls and Women (IAPESGW)	17-21 Mayo Miami (EEUU)	web: www.barry.edu/iapesgw
12º Congreso Bienal SETRADE	18-19 Mayo Pontevedra	E-mail: secretaria@setrade.org web: www.setrade.org/congresos/12setrade/
ACSM Annual Meeting, World Congress on Exercise is Medicine® and World Congress on The Basic Science of Energy Balance	30 Mayo-3 Junio Denver, Colorado (EE.UU.)	web: www.acsm.org/
Movement 2017	9-11 Junio Oxford (Reino Unido)	web: www.movementis.com
5th CSIT World Sports Games	11-18 Junio Riga (Letonia)	web: www.csit.tv/en/world-sports-games
8th Asia-Pacific Conference on Exercise and Sports Science (APCESS 2017)	14-16 Junio Bangkok (Tailandia)	web: http://apcess2017.kasetsart.org/index.php
V Simposium Internacional de Biomecánica y Podología Deportiva	16-17 Junio Málaga	web: www. aepode.org
Congreso Mundial de Fisioterapia (WCPT)	2-4 Julio Cape Town (Rep. Sudáfrica)	web: www.wcpt.org/congress

23 European Society of Biomechanics Congress	2-5 Julio Sevilla	Web: https://esbiomech.org/newsletter/esbiomech-newsletter-april-2015/save-the-date-esb-2017-seville/
22nd annual Congress of the European College of Sport Science	5-8 Julio Ruhr Bochum (Alemania)	E-mail: congress@ecss.de web: www.ecss-congress.eu/2017
XIV Congreso Mundial de Psicología del Deporte	10-14 Julio Sevilla	web: www.issp2017.com/
International conference of sport science Asian Exercise and Sport Science Association (AESA)	20 Julio Mahmud Abada (Irán)	web. www.2017.aesasport.com/en/
27º Congress European Society for surgery of the shoulder and the elbow (SECEC-ESSSE)	13-16 Septiembre Berlín (Alemania)	web: www.secec2017.com
54º Congreso Nacional de la Sociedad Española de Cirugía Ortopédica y Traumatología (SECOT)	27-29 Septiembre Barcelona	web: www.secot.es
II World Conference of Sports Physiotherapy	6-7 Octubre Belfast (Irlanda del Norte)	web: www.physiosinsport.org
XXI Congreso Internacional de Nutrición	15-20 Octubre Buenos Aires (Argetina)	web: www.icn2017.com
48 Congreso Nacional de Podología	20-22 Octubre Salamanca	web: www.aepode.org / http://www.cgcop.es/
10th EFSMA (European Federation of Sports Medicine Associations) Congress	16-18 Noviembre Cascais (Portugal)	Email: secretariat@efsma2017.org web: www.efsma2017.org
XXI Congreso Anual AEMEF	Valladolid	E-mail: comunicación@aemef.org web: www.aemef.org
2018		
World Congress on Osteoporosis, Osteoarthritis and Musculoskeletal Diseases	19-22 Abril Cracovia (Polonia)	web: www.wco-iof-esceo.org/
23rd Annual Congress of the European College of Sport Science	4-7 Julio Dublín (Irlanda)	web: www.ecss-congress.eu/2018/
24th Annual Congress of the European College of Sport Science	Praga (Rep. Checa)	E-mail: office@sport-science.org
28º Congress European Society for surgery of the shoulder and the elbow (SECEC-ESSSE)	Ginebra (Suiza)	web: www.secec.org
XXXV Congreso Mundial de Medicina del Deporte	12-15 Septiembre Rio de Janeiro (Brasil)	web: www.fims.org

2019		
14th International Congress of shoulder and elbow surgery (ICSES)	17-20 Septiembre Buenos Aires (Argentina)	web: www.icses2019.org
24th Annual Congress of the European College of Sport Science	Praga (Rep. Checa)	E-mail: office@sport-science.org

Campaña de aptitud física, deporte y salud

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

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

Cursos *on-line* SEMED-FEMEDE

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

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

Curso "ELECTROCARDIOGRAFÍA PARA MEDICINA DEL DEPORTE"

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

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

Curso "FISIOLOGÍA Y VALORACIÓN FUNCIONAL EN EL CICLISMO"

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

Curso "AYUDAS ERGOGÉNICAS"

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

Curso "CARDIOLOGÍA DEL DEPORTE"

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

Fecha límite de inscripción: 15/06/2017

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

Curso "ALIMENTACIÓN, NUTRICIÓN E HIDRATACIÓN EN EL DEPORTE"

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

Curso "ALIMENTACIÓN Y NUTRICIÓN EN EL DEPORTE"

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

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

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

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

Más información:
www.femede.es

SYNVISC HYLAN G-F 20 **2 ml** SYNVISC ONE HYLAN G-F 20 **6 ml**

DESCRIPCIÓN

El hilano G-F 20 se encuentra disponible en dos presentaciones:

• **Synvisc®** (presentación de 2 ml).

• **Synvisc-One®** (presentación de 6 ml).

El Hilano G-F 20 es un fluido elastoviscoso, estéril y apirógeno, que contiene polímeros de hilano A e hilano B producidos a partir de un extracto aviar altamente purificado. Los hilanos son productos derivados del hialuronato (sal sódica de ácido hialurónico), constituidos por disacáridos repetidos de N-acetilglucosamina y glucuronato sódico. El hilano A tiene un peso molecular medio de aproximadamente 6.000.000 y el hilano B es un gel hidratado. El hilano G-F 20 contiene hilano A e hilano B (8,0 mg ± 2,0 mg por ml) en solución fisiológica tamponada de cloruro sódico (pH 7,2 ± 0,3).

CARACTERÍSTICAS

El hilano G-F 20 es biológicamente similar al hialuronato. El hialuronato es un componente del líquido sinovial responsable de su elastoviscosidad. Sin embargo, las propiedades mecánicas (elastoviscosas) del hilano G-F 20 son superiores a las del líquido sinovial y de las soluciones de hialuronato de concentración comparable. El hilano G-F 20 tiene una elasticidad (módulo de almacenamiento G´) a 2,5 Hz de 111 ± 13 Pascales (Pa) y una viscosidad (módulo de pérdida G˝) de 25 ± 2 Pa. Elasticidad y viscosidad del fluido sinovial de la rodilla de humanos de 18 a 27 años de edad medidas con un método comparable a 2,5 Hz son G´ = 117 ± 13 Pa y G˝ = 45 ± 8 Pa. La degradación de los hilanos en el organismo sigue la misma vía que el hialuronato y sus productos de degradación carecen de toxicidad.

INDICACIONES Y MODO DE EMPLEO

El hilano G-F 20:

- Sustituye temporalmente y suplementa el líquido sinovial.
- Es eficaz en cualquier estadio de la patología articular.
- Es particularmente eficaz en pacientes que utilizan activa y regularmente la articulación afectada.
- Su efecto terapéutico se debe a la viscosuplementación, un proceso mediante el cual se restaura el estado fisiológico y reológico de los tejidos de la articulación con osteoartritis.

La viscosuplementación que se consigue mediante el tratamiento con hilano G-F 20 disminuye el dolor y las molestias, permitiendo una mayor amplitud de movimiento de la articulación. Estudios *in vitro* han demostrado que el hilano G-F 20 protege las células cartilaginosas contra ciertas lesiones físicas y químicas. **Synvisc** ha sido concebido exclusivamente para la aplicación intraarticular por un médico, para el tratamiento del dolor asociado a la osteoartritis de rodilla, cadera, tobillo y hombro.

Synvisc-One ha sido concebido exclusivamente para la aplicación intraarticular por un médico, para el tratamiento del dolor asociado a la osteoartritis de rodilla.

CONTRAINDICACIONES

- No deberá inyectarse hilano G-F 20 en la articulación cuando exista estasis venosa o linfática en el miembro respectivo.
- El hilano G-F 20 no deberá utilizarse en articulaciones infectadas o intensamente inflamadas ni en pacientes que sufran enfermedades o infecciones de la piel en el área de aplicación de la inyección.

ADVERTENCIAS

- No inyectar intravascularmente.
- No inyectar en forma extraarticular o dentro de los tejidos y la cápsula sinovial. Efectos adversos, generalmente en el área de la inyección, han ocurrido después de la inyección extraarticular de **Synvisc**.
- No debe utilizarse junto a desinfectantes que contengan sales amónicas cuaternarias para la preparación de la piel ya que el hialuronato puede precipitarse en su presencia.

PRECAUCIONES

- El hilano G-F 20 no debe utilizarse si se produce un gran exudado intraarticular antes de la inyección.
- Como en todo proceso de invasión de articulación, se recomienda al paciente evitar toda actividad física intensa después de la inyección intraarticular y continuar con las actividades habituales pasados algunos días.
- El hilano G-F 20 no ha sido probado en mujeres embarazadas ni en menores de 18 años.
- El hilano G-F 20 contiene pequeñas cantidades de proteína aviar, por lo que no se debe utilizar en pacientes con hipersensibilidad a dicha proteína.

EFECTOS ADVERSOS

- Efectos adversos que afectan al miembro inyectado: dolor transitorio, hinchazón y/o exudación en la articulación inyectada después de las inyecciones intraarticulares de hilano G-F 20. Tras la inyección intraarticular de **Synvisc** o **Synvisc-One** se han notificado casos de inflamación aguda, caracterizados por dolor, hinchazón, exudación y a veces calor y/o rigidez en la articulación. En el análisis del líquido sinovial se constata la existencia de líquido aséptico sin cristales. Esta reacción suele producirse en unos cuantos días como respuesta al tratamiento con fármacos antiinflamatorios no esteroideos (AINE), esteroides intraarticulares y/o artrocientesis. El beneficio clínico del tratamiento es evidente después de dichas reacciones.
- Los ensayos clínicos de **Synvisc/Synvisc-One** no han evidenciado ninguna infección intraarticular y son pocos los casos de los que se han informado durante el uso clínico de **Synvisc**.
- También se ha informado de reacciones de hipersensibilidad, incluidas reacción anafiláctica, reacción anafilactoide, choque anafiláctico y angioedema. La experiencia tras su comercialización ha identificado los siguientes efectos sistémicos que aparecen rara vez con la administración de **Synvisc**: erupción cutánea, urticaria, comezón, fiebre, náuseas, dolor de cabeza, mareos, escalofríos, calambres, parestesia, edema periférico, malestar, dificultades respiratorias, enrojecimiento y tumefacción faciales.
- En ensayos clínicos controlados con **Synvisc** no hubo diferencias estadísticamente significativas en el número de efectos adversos sistémicos entre el grupo de pacientes que recibió **Synvisc** y el que recibió tratamientos de control.
- En ensayos clínicos controlados con **Synvisc-One** se observó que el tipo de efectos adversos ocurridos y la frecuencia con que se detectaron eran similares en el grupo de pacientes que recibió **Synvisc-One** y el grupo tratado con placebo.

DOSIFICACIÓN Y ADMINISTRACIÓN

- No utilice el hilano G-F 20 si el envase está abierto o deteriorado.
- Utilice el contenido de la jeringa inmediatamente después de abrir el envase.
- Retire el líquido o exudado sinovial antes de inyectar hilano G-F 20.
- La inyección deberá realizarse a temperatura ambiente.
- Para extraer la jeringa del envase (o bandeja), sujétela por el cuerpo, sin tocar el émbolo.
- La administración debe realizarse en condiciones asépticas, teniendo especial cuidado al abrir el tapón de la punta de la jeringa.
- Gire el tapón gris antes de tirar del mismo para evitar pérdidas del producto.
- Utilice una aguja de tamaño adecuado:
- **Synvisc**, calibre 18 a 22.

Elija una aguja de longitud apropiada en función de la articulación que vaya a tratar.

- **Synvisc-One**, calibre 18 a 20
- Para asegurar un sellado hermético y prevenir pérdidas durante la administración, asegure la aguja correctamente mientras sostiene con firmeza el adaptador Luer de la jeringa.
- No apriete excesivamente ni haga palanca al fijar la aguja o al extraer su protector, ya que podría romperse la punta de la jeringa.
- Inyecte únicamente en el espacio sinovial recurriendo, si es necesario, a orientación adecuada, como la fluoroscopia, especialmente en articulaciones tales como la cadera y el hombro.
- El contenido de la jeringa es para un solo uso. Las instrucciones de dosificación recomendadas indican que debe inyectarse el volumen completo de la jeringa (2 ml para **Synvisc** y 6 ml para **Synvisc-One**).
- No reutilice la jeringa ni la aguja. La reutilización de jeringas, agujas y/o cualquier producto de una jeringa usada puede comprometer la esterilidad del producto, causar su contaminación y/o perjudicar el tratamiento.
- Cuando utilice guía fluoroscópica, puede emplear un agente de contraste iónico o no iónico. No debe utilizarse más de 1 ml de agente de contraste por cada 2 ml de hilano G-F 20.
- No reesterilice el hilano G-F 20.

POSOLOGÍA Y DOSIS MÁXIMA RECOMENDADA

El régimen de dosis de hilano G-F 20 depende de la articulación que se esté tratando.

Osteoartritis de rodilla:

Synvisc

El régimen de tratamiento recomendado consiste en una serie de tres inyecciones de 2 ml en la rodilla, con una semana de separación entre ellas. Para obtener el máximo efecto, es esencial la administración de la serie completa, es decir, las tres inyecciones. La dosis máxima recomendada es de seis inyecciones en 6 meses y con un mínimo de 4 semanas entre regímenes de tratamiento.

Synvisc-One

El régimen de tratamiento recomendado es una inyección de 6 ml en la rodilla, que puede repetirse a los 6 meses si los síntomas del paciente lo exigen.

Osteoartritis de cadera / tobillo / hombro:

Synvisc

El régimen de tratamiento inicial recomendado es una sola inyección de 2 ml. Sin embargo, si tras esa inyección no se logra el alivio sintomático adecuado, se recomienda aplicar una segunda inyección de 2 ml. Los datos clínicos han demostrado que los pacientes se benefician de esta segunda inyección si se administra entre uno y tres meses después de la primera.

DURACIÓN DEL EFECTO

El tratamiento con hilano G-F 20 únicamente afecta a la articulación inyectada, no produce efectos sistémicos generales.

Synvisc

En general, se ha informado de que la duración del efecto en pacientes que responden al tratamiento es de hasta 26 semanas, si bien se han observado períodos más cortos y más largos. Sin embargo, los datos clínicos prospectivos de pacientes con osteoartritis de rodilla han demostrado que, tras aplicar una única serie de tres inyecciones de **Synvisc**, los beneficios del tratamiento se han prolongado hasta 52 semanas.

Synvisc-One

Los datos de algunos ensayos clínicos prospectivos en pacientes con osteoartritis de rodilla han mostrado una reducción del dolor hasta 52 semanas después de una única inyección de **Synvisc-One** además de mejoras relacionadas con la rigidez y la capacidad funcional.

Los datos clínicos de un ensayo controlado, aleatorizado, doble ciego en pacientes con osteoartritis de rodilla han mostrado una reducción estadística y clínicamente significativa del dolor en comparación con el placebo. Se trató a un total de 253 pacientes (124 recibieron **Synvisc-One** y 129 recibieron placebo). En el transcurso de 26 semanas, los pacientes que habían recibido **Synvisc-One** demostraron un cambio porcentual medio del dolor en relación con el valor inicial del 36%, mientras que los pacientes en el grupo que recibió placebo presentaron un cambio porcentual medio del dolor en relación con el valor inicial del 29%.

Otros datos clínicos prospectivos procedentes de dos estudios multicéntricos abiertos en pacientes con osteoartritis de rodilla han mostrado mejoras estadísticamente significativas en el alivio del dolor en comparación con el valor inicial hasta 52 semanas después de una única administración de **Synvisc-One**.

En el primer estudio, 394 pacientes que recibieron **Synvisc-One** demostraron un cambio estadísticamente significativo en la subpuntuación WOMAC A1 (dolor al caminar) (-28 ± 19,89 mm en una EVA de 100 mm) en relación con el valor inicial durante 26 semanas. Además, se observaron cambios estadísticamente significativos en relación con el valor inicial en las puntuaciones WOMAC A1, WOMAC A, B y C en los seis períodos de observación entre las semanas 1 y 52, lo cual demuestra mejoras en el dolor al caminar y en el dolor (WOMAC A1: -32,7 ± 19,95 mm; WOMAC A: -29,18 ± 19,155 mm), la rigidez (WOMAC B: -25,77 ± 22,047 mm) y la capacidad funcional (WOMAC C: -25,72 ±19,449 mm) durante 52 semanas.

En el segundo estudio, 571 pacientes que recibieron **Synvisc-One** demostraron una mejora estadísticamente significativa en el dolor durante 26 semanas, según la medición mediante un cuestionario verbal del dolor (Verbal Pain Questionnaire, VPQ). La evaluación media del dolor mejoró de 3,20 en el momento inicial a 2,24 en la visita de la semana 26 y un 64,6 % de los pacientes obtuvo alivio del dolor. Los criterios de valoración secundarios mostraron una mejora estadísticamente significativa en las puntuaciones VPQ en todos los momentos de observación desde la semana 1 hasta la 52, con puntuaciones VPQ en descenso de 3,20 en el momento inicial a 2,26 en la visita de la semana 52. Un 61,5 % de los pacientes obtuvo alivio del dolor.

CONTENIDO POR ml (hilano G-F 20)

1 ml de **Synvisc** contiene: hilano 8,0 mg; cloruro sódico 8,5 mg; fosfato disódico hidrogenado 0,16 mg; fosfato sódico dihidrogenado 0,04 mg; agua para inyección c.s.

PRESENTACIÓN

El contenido de cada jeringa es estéril y apirógeno. Conservar a una temperatura de entre 2°C y 30°C. No congelar.

Synvisc se presenta en jeringas de vidrio de 2,25 ml, que contienen 2 ml de hilano G-F 20.

Synvisc-One se suministra en una jeringa de vidrio de 10 ml con 6 ml de hilano G-F 20.

INFORMACIÓN PARA LOS PACIENTES

Antes de la inyección, informe al paciente de que Synvisc y Synvisc-One están compuestos por ácido hialurónico altamente purificado de origen aviar.

Normas de publicación de Archivos de Medicina del Deporte

La Revista ARCHIVOS DE MEDICINA DEL DEPORTE (A.M.D.) con ISSN 0212-8799 es la publicación oficial de la Federación Española de Medicina del Deporte. Edita trabajos originales sobre todos los aspectos relacionados con la Medicina y las Ciencias del Deporte desde 1984 de forma ininterrumpida con una periodicidad trimestral hasta 1995 y bimestral a partir de esa fecha. Se trata de una revista que utiliza fundamentalmente el sistema de revisión externa por dos expertos (peer-review). Incluye de forma regular artículos sobre investigación clínica o básica, revisiones, artículos o comentarios editoriales, y cartas al editor. Los trabajos podrán ser publicados EN ESPAÑOL O EN INGLÉS. La remisión de trabajos en inglés será especialmente valorada.

En ocasiones se publicarán las comunicaciones aceptadas para presentación en los Congresos de la Federación.

Los artículos Editoriales se publicarán sólo previa solicitud por parte del Editor.

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1. Los trabajos deberán ser remitidos, a la atención del Editor Jefe, escritos a doble espacio en hoja DIN A4 y numerados en el ángulo superior derecho. Se recomienda usar formato Word, tipo de letra Times New Roman tamaño 12. Deberán enviarse por correo electrónico a la dirección de FEMEDE: femede@femede.es.
2. En la primera página figurarán exclusivamente y por este orden los siguiente datos: título del trabajo (español e inglés), nombre y apellidos de los autores en este orden: primer nombre, inicial del segundo nombre si lo hubiere, seguido del primer apellido y opcionalmente el segundo de cada uno de ellos; titulación oficial y académica, centro de trabajo, dirección completa y dirección del correo electrónico del responsable del trabajo o del primer autor para la correspondencia. También se incluirán los apoyos recibidos para la realización del estudio en forma de becas, equipos, fármacos… Se adjuntará una carta en la que el primer autor, en representación de todos los firmantes del estudio, efectúa la cesión de los derechos de reproducción total o parcial sobre el artículo, en caso de ser aceptado para ser publicado.

   Además, en documento adjunto, el responsable del envío propondrá un máximo de cuatro revisores que el editor podrá utilizar si lo considera necesario. De los propuestos, uno al menos será de nacionalidad diferente del responsable del trabajo. No se admitirán revisores de instituciones de los firmantes del trabajo.
3. En la segunda página figurará el resumen del trabajo en español e inglés, que tendrá una extensión de 250-300 palabras. Incluirá la intencionalidad del trabajo (motivo y objetivos de la investigación), la metodología empleada, los resultados más destacados y las principales conclusiones. Ha de estar redactado de tal modo que permita comprender la esencia del artículo sin leerlo total o parcialmente. Al pie de cada resumen se especificarán de tres a diez palabras clave en castellano e inglés (keyword), derivadas del *Medical Subject Headings* (MeSH) de la *National Library of Medicine* (disponible en: http://www.nlm.nih.gov/mesh/MBrowser.html).
4. La extensión del texto variará según la sección a la que vaya destinado:
   a. Originales: máximo de 5.000 palabras, 6 figuras y 6 tablas.
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   a. **ORIGINALES**: Constará de una introducción, que será breve y contendrá la intencionalidad del trabajo, redactada de tal forma que el lector pueda comprender el texto que le sigue. **Material y método**: Se expondrá el material utilizado en el trabajo, humano o de experimentación, sus características, criterios de selección y técnicas empleadas, facilitando los datos necesarios, bibliográficos o directos, para que la experiencia relatada pueda ser repetida por el lector. Se describirán los métodos estadísticos con detalle. **Resultados**: Relatan, no interpretan, las observaciones efectuadas con el material y método empleados. Estos datos pueden publicarse en detalle en el texto o bien en forma de tablas y figuras. No se debe repetir en el texto la información de las tablas o figuras. **Discusión**: Los autores expondrán sus opiniones sobre los resultados, posible interpretación de los mismos, relacionando las propias observaciones con los resultados obtenidos por otros autores en publicaciones similares, sugerencias para futuros trabajos sobre el tema, etc. Se enlazarán las conclusiones con los objetivos del estudio, evitando afirmaciones gratuitas y conclusiones no apoyadas por los datos del trabajo. Los agradecimientos figurarán al final del texto.

b. **REVISIONES DE CONJUNTO**: El texto se dividirá en todos aquellos apartados que el autor considere necesarios para una perfecta comprensión del tema tratado.
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   - **Capítulo en libro**: Autores, título del capítulo, editores, título del libro, ciudad, editorial, año y páginas. Ejemplo: Iselin E. Maladie de Kienbock et Syndrome du canal carpien. En: Simon L, Alieu Y. *Poignet et Medecine de Reeducation*. Londres: Collection de Pathologie Locomotrice Masson; 1981. p. 162-6.
   - **Libro**. Autores, título, ciudad, editorial, año de la edición, página de la cita. Ejemplo: Balius R. *Ecografía muscular de la extremidad inferior. Sistemática de exploración y lesiones en el deporte.* Barcelona. Editorial Masson; 2005. p. 34.
   - **Material eléctrónico, artículo de revista electrónica**: Ejemplo: Morse SS. Factors in the emergence of infectious diseases. *Emerg Infect Dis*. (revista electrónica) 1995 JanMar (consultado 0501/2004).
     Disponible en: http://www.cdc.gov/ncidod/EID/ eid.htm

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Cuando exista alguna relación entre los autores de un trabajo y cualquier entidad pública o privada de la que pudiera derivarse un conflicto de intereses, debe de ser comunicada al Editor. Los autores deberán cumplimentar un documento específico.

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Los trabajos que se envían a la Revista ARCHIVOS DE MEDICINA DEL DEPORTE para evaluación deben haberse elaborado respetando las recomendaciones internacionales sobre investigación clínica y con animales de laboratorio, ratificados en Helsinki y actualizadas en 2008 por la Sociedad Americana de Fisiología (http://www.wma.net/es/10home/index.html).

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