



## ECCENTRIC EXERCISE IN TREATMENT OF PATELLAR TENDINOPATHY IN HIGH LEVEL BASKETBALL PLAYERS. A RANDOMIZED CLINICAL TRIAL

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### INTRODUCTION

Chronic patellar tendinopathy is a common pathology in sporting population. To date, there is no agreed upon protocol as election treatment (1, 2). Eccentric exercises have been used with satisfactory outcomes (3). The purpose of this trial is compare the effects of two eccentric exercise protocols.

### METHODS

A prospective randomized clinical trial was constructed with a one month follow-up. Six high level basketball players (8 tendons) were recruited and randomized to one of two treatment groups (G1=4; G2=4). Pain and function were evaluated through EVA and VISA-P questionnaires before, during, and after the treatment. Group A: Based on Durham's protocol (4), it consisted of 3 sets of 15 repetitions, using no added weight, of half squats on a 25° declined platform, 2 times per day, 7 days per week. Group B: Consisted of 4 sets of 6 repetitions with 100% of 1MR for one leg, 3 days per week, in non-consecutive days, in leg extension machine. Both protocols were done with no restriction of competition.

### RESULTS

After 4 weeks the outcomes showed that, despite improvement in both groups, none of the protocols reported a significant improvement in VAS or VISA-P. When analyzing the outcomes for VAS, in Group A the values decreased below baseline. Regarding the VISA-P values, Group A

improved strength and function when pain perception decreased. In group B values kept a sustained growth. Comparing both protocols, no significant differences are noted in VAS values ( $Z=1,01$ ;  $p>0,05$ ) or VISA-P ( $Z=0,20$ ;  $p>0,05$ ).

### DISCUSSION

Most of studies used Durham's protocol (4) combined with restriction of competition, with satisfactory results. We propose another eccentric protocol that includes overload training, to improve strength, and no restriction of competition. After 4 weeks of eccentric exercise protocol most of tendons in both groups improve function during treatment but does not significantly. Despite no significant difference we propose managing the tendinopathy with eccentric exercises during the competitive season to avoid deterioration.

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## STAPHYLOCOCCUS AUREUS OUTBREAK ASSOCIATED WITH NASAL CARRIERS AND PERSPIRATION AMONG RUGBY PLAYERS

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### INTRODUCTION

*Staphylococcus aureus* (SA) causes wound infection [1] and it is transmitted during physical contact sports [2]. An outbreak of SA occurred among a college rugby team infected 14 players. The infection rate was higher among forward, than back players (28% vs. 7%). We conducted a nasal-swab survey of 70 rugby football players after SA outbreaks, and found that 17% (12/70) were persistent nasal carriers. To better understand SA dissemination during physical contact sports, we compared the appearance of skin surface SA between nasal SA carriers and non-carriers before and after exercise.

### METHODS

The skin of 16 healthy adult males (age, 20.1 ± 1.3 y) was swabbed before and after bicycle exercise for 15 min. Skin surface swabs were undertaken pre and post bicycle exercise. Placed swabs in PBS, and promptly delivering them to the laboratory. An aliquot was plated onto paired mannitol Compact Dry X-SA (CD-XSA; Nissui Pharmaceutical)[3]. Each sample were cultured on CD-XSA for 24h at 37°C. After incubation, SA grew as blue colonies on the media. Total colony-forming units (CFUs) were counted on a medium.

### RESULTS

Significantly more SA colonies were found on the skin surface after (post-EX) than before (pre-EX) exercise (35.8 ± 41.6 vs. 5.0 ± 5.2 CFU/15 cm<sup>2</sup>;  $P = 0.015$ ) and the numbers of nasal and skin surface SA colonies closely correlated ( $P = 0.021$ ).

### DISCUSSION

These results suggest that exercise-induced moistening of the skin with sweat significantly increases the amount of SA among nasal carriers. Because sweat on the skin surface might be associated with SA transmission among rugby players, athletes involved in physical contact sports should shower immediately after training or competition, and the importance of eliminating nasal SA should be emphasized.

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## VITAMIN C AND E SUPPLEMENTATION EFFECTS IN INTERLEUKIN-6 AND C- REACTIVE PROTEIN SECRETION

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### INTRODUCTION

Exercise increases several inflammation markers, especially Interleukin-6 (IL-6) and C-reactive protein (CRP)(1). Some studies have linked the exercise-induced production of IL-6 and CRP with the observed elevation of hepcidin after exercise(1). Therefore, these responses are proposed to explain iron deficiency among athletes. The aim of this study was to elucidate the effect of vitamin C and E supplementation in the inflammatory response after exercise in healthy humans.

### METHODS

Ten well-trained male students of Sport Sciences (26.9±6.7 years, 69.3±8.8kg and 176.6±7.5cm) participated in this study. Subjects received an oral supplementation with a combination of ascorbic acid (500mg/day) and RRR- $\alpha$ -tocopherol (400IU/day). Before and after 28 days of supplementation the participants performed 1.5h running trial at the speed corresponding to the 75% of the maximum oxygen consumption ( $VO_{2max}$ ) previously determined. Venous blood samples were obtained pre-trial (BS), immediately post-trial (0 h), and at 3, 6, and 10 h post-trial.

### RESULTS

IL-6(BS: 0.358±0.251 vs. 0.365±0.311 pg/mL; 0 h: 16.115±7.879 vs. 15.685±6.510pg/mL; 3 h: 8.553±6.150 vs. 4.748±3.201 pg/mL; 6 h: 8.381±11.989 vs. 3.568±2.834 pg/mL; 10 h: 9.062±15.519 vs. 3.241±3.641 pg/mL, before and after supplementation respectively) and CRP(BS: 0.036±0.019 vs. 0.048±0.037 mg/dL; 0 h: 0.036±0.018 vs.

0.049±0.035 mg/dL; 3 h: 0.035±0.018 vs. 0.048±0.034 mg/dL; 6 h: 0.057±0.036 vs. 0.074±0.050 mg/dL; 10 h: 0.125±0.086 vs. 0.125±0.095 mg/dL, before and after supplementation respectively) levels were not significantly different after supplementation). However, both responses were significantly higher after exercise regarding to baseline levels.

### DISCUSSION

Fischer et al. (2) reported that vitamins C and E inhibit the release of IL-6 from contracting human skeletal muscle. By contrast, there were not IL-6 and CRP inhibition after supplementation in our study. Although the response of IL-6 tended to be lower after supplementation, this reduction was not significant. Nevertheless, there was an increase of inflammatory response after exercise regarding to baseline levels such as Peeling et al. showed in their study (3). More studies are necessary to understand these complex mechanisms.

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## QEEG AND NEUROMODULATION (TRNS / TRANSCRANIAL RANDOM NOISE STIMULATION) APPLICATIONS FOR SPORT AND HIGH PERFORMANCE

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### INTRODUCTION

Quantitative electroencephalography (QEEG) reflects brain electrical activity and can help us to understand processes that underlie skilled performing. A common problem with EEG is that brainwaves data is often contaminated by artifacts of non-cerebral origin. Unfortunately, such artifacts tend to be exacerbated when the subject is in motion; therefore obtaining reliable data during exercise is not an easy task. These problems may explain the limited number of studies using QEEG as a methodological tool in the sports sciences. Not to collect movement artifacts during EEG recording we use alternative paradigms which avoid recording during physical exertion. With practical and computational techniques we confront the challenges in raw EEG recording during physical exercise. We propose brain noninvasive stimulation tRNS as neuromodulation technique to train peak-performance. A knowledge of practical aspects of EEG recording along with the advent of supercomputing offer a promising approach to obtain reliable EEG data during motion or to optimise high-performance in sports.

### METHODS

Thirty semi professional sport subjects 52% females and 48% males, from 10 to 19 years old. Half of them participate in this training program during six months with Neuromodulation (tRNS) or without Neuromodulation techniques. All of them record a QEEG and ERP in GO/NOGO paradigm before and after 6 months of training.

### RESULTS

Sport who had been training during 6 months with Brain-noninvasive Stimulation methodology showed a significant increase in sport performance during and after stimulation sessions comparing to control group that did train without Neuromodulation techniques.

### DISCUSSION

The increase in peak performance by providing neuromodulation based in QEEG/ERP endophenotype reduces fatigue during exercise and improves attention, speed, inhibitory response and anticipatory response ( $p \leq 0.001$ ). Some QEEG endophenotypes like ADHD with SMR rhythm in central cortex has an optimal performance in sports. Other neuromodulation techniques like non-invasive brain stimulation can improve inhibitory responses during a football game or tennis.

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## TRADITIONAL VS CLUSTER SET CONFIGURATION: NEUROPHYSIOLOGICAL AND HEMODYNAMIC RESPONSES

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### INTRODUCTION

Resistance training is traditionally designed by one or several sets of a number of repetitions in every exercise. While traditional set configuration requires performing each repetition in a continuous fashion where no rest is taken in between each repetition, cluster training consists of manipulating work and rest periods by breaking sets into small clusters of repetitions (1). The aim of this study was to describe the neurophysiological, mechanical and hemodynamic acute responses of traditional and cluster set configuration when they were equated with respect to volume, intensity and work-to-rest ratio.

### METHODS

Eleven healthy sport science students participated in a total of 8 sessions, 5 of familiarization and 3 experimental sessions. The first one was conducted in order to calculate the time to failure during an isometric knee extensor exercise. This time was used to establish the individual work-pause for the cluster and traditional training sessions (conducted in counterbalance order and one week apart). Neurophysiological and dynamic parameters were recorded before and after training sessions. Motor evoked potential (MEP), Short intracortical inhibition (SICI) and Intracortical facilitation (ICF) were measured using transcranial magnetic stimulation device; voluntary activation (VA), twitch force (TF), maximal M wave (Mmax) and low frequency fatigue (LFF) were calculated by electrical nerve stimulation. Maximal voluntary contraction (MVC), rate of force development (RFD) were recorded with a load

cell. Hemodynamic parameters Heart Rate (HR), mean blood pressure (MBP), Heart Rate Variability in frequency domain (total Power, low and high frequency; TP, LF, HF, respectively) were assessed also during the session. In addition, subjective perception of effort was also measured.

### RESULTS

ANOVAs showed a significant session\*time interactions ( $p < 0.05$ ) over the following variables: MEP, SICI, VA, TF, Mmax, LFF, HR, MBP, PSD, LF and HF, MVC and RFD. Post-Hoc analysis showed significant differences before and after for each session. However, there were significant differences between cluster and traditional training at the end of the sessions, indicating a higher change of these variables for the traditional session in comparison with the cluster session.

### DISCUSSION

Traditional set configuration implicates higher central and peripheral fatigue with subsequent loss in maximal force values as well as greater hemodynamic stress, even when both training sessions were equated for the work-pause rate. This study could contribute to a better understanding of the physiological mechanisms underlying the cluster configuration.

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## EFFICACY OF DRY NEEDLING IN ELDERLY WITH NONSPECIFIC SHOULDER PAIN: PILOT RANDOMIZED CONTROLLED CLINICAL TRIAL

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### INTRODUCTION

Shoulder pain has a high prevalence in elderly people and provokes functional alterations (1). So, there are difficulties for its clinical diagnosis, lack of effectiveness in the treatment and not much evidence regarding invasive physiotherapy techniques in this population (2). Purpose: To determine the efficacy of a single physiotherapy intervention with deep dry needling on latent and active myofascial trigger points in older adults with nonspecific shoulder pain.

### METHODS

Pilot study, single blind randomized controlled clinical trial on 20 subjects aged 65 and over with nonspecific shoulder pain. The study was approved by an ethics committee and based on previous studies (3,4). Sample was recruited at their home and at a care center, and randomly distributed in Experimental Group (n=10), which received a session of deep dry needling on an active and a latent myofascial trigger points of the infraspinatus muscle; and Control Group (n=10), receiving a session only on an active myofascial trigger point. A blind examiner evaluated pain intensity, pain pressure threshold (anterior deltoid; extensor carpi radialis brevis) and maximal grip strength, before, immediately after intervention and after a week of treatment.

### RESULTS

Statistically significant differences ( $p < 0.05$ ) in pressure pain threshold of the extensor carpi radialis brevis

were found in the Experimental Group, immediately and a week after treatment. The effect size values (d Cohen) immediately and after a week varied from small for strength (0.017; 0.36), moderate for pain intensity (0.46; 0.78) and pressure pain threshold in anterior deltoid (0.49; 0.66), to very high for pressure pain threshold in extensor carpi radialis brevis (1.06; 1.58).

### DISCUSSION

Deep dry needling on latent myofascial trigger points of the infraspinatus muscle increases the Pressure Pain Threshold on epicondyle musculature, immediately and after a week, in the elderly with non-specific shoulder pain, coinciding with the same segmentary level of innervation according to previous studies (3,4). In spite of the lack of a placebo control group, dry needling could be an important consideration in the resistance training and fitness in the elderly.

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## IMPROVING QUALITY OF LIFE AND FITNESS IN A WOMAN WITH PARKINSON'S DISEASE. A CASE STUDY

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### INTRODUCTION

Physical activity levels decrease faster in seniors suffering from Parkinson's Disease (PD) compared to healthy individuals. Furthermore, research has shown that exercise stimulates dopamine synthesis, decreasing PD symptoms (1). The purpose of this case study was to measure the efficacy of a 5-month intervention in a woman with PD. In accordance with evidence-based guidelines (2), a multifactorial exercise intervention (MEI) was designed with five goal-oriented training protocols: cognitive movement strategies, cueing strategies, balance, joint mobility and muscular power.

### METHODS

The participant was a 71-year-old woman with mid-phase PD, (4 points on the Hoen and Yahr scale (3)). She completed a 5-month program consisting of bi-weekly supervised training and daily self-regulated exercise. Senior Fitness Test (SFT) (4), United Parkinson's Disease Rating Scale (UPDRS) (5), Berg Balance Scale (BBS) (5) and The Parkinson's Disease Questionnaire (PDQ-39) (6) scores were compared in a pre-post analysis.

### RESULTS

The participant showed improvement in all measures. Her SFT score increased from Below Average, or At risk for loss of functional mobility, to the Normal Range score in four out of the five tests. Her UPDRS section III score decreased from 37 to 17 points and her BBS score improved from 26 to 43. PDQ-39 showed a moderate decrease in

the total score (82% to 74%) with greater improvements in [the categories] Stigma (88% to 63%), Emotional Well-being (88% to 75%) and Bodily Discomfort (83% to 67%).

### DISCUSSION

As expected (1), the outcomes provide preliminary evidence of improved quality of life and fitness markers, following an MEI in women suffering from PD. Larger studies are needed to confirm these findings and investigate whether a causal relationship exists between MEI and improvement in physical function in women with PD, and how that impact motor performance and quality of life measures.

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## ARTERIAL STIFFNESS AFTER AN EXERCISE PROGRAM IN PATIENTS SUFFERING FROM CHRONIC OBSTRUCTIVE PULMONARY DISEASE (COPD)

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### INTRODUCTION

Arterial stiffness, a strong predictor of cardiovascular mortality, is abnormally elevated in patients with chronic obstructive pulmonary disease (1). Although exercise training is one of the most powerful interventions to provide symptomatic relief in patients with COPD it is unclear the influence of exercise on arterial stiffness (2). The purpose of this study was to assess whether strength combined with HIIT training may decrease arterial stiffness in elderly patients with COPD.

### METHODS

Twelve male COPD patients ( $83.7 \pm 2.9$  years) from Geriatric Hospital Virgen del Valle participated in the study. A cross over design study was used. Patients followed a 9-week strength + HIIT exercise program (two sessions per week, 45 minutes-session). Exercise program was supervised by heart rate (HR), Borg RPE scale and oxygen saturation (SpO<sub>2</sub>) with a pulse oxymeter. Carotid-radial pulse wave velocity (PWV), pulmonary function, basal HR, systolic and diastolic blood pressure and the six-minute walk test (6MWT) were measured before and will be measured after the intervention. Subjects' COPD level was calculated according to their Body mass index, airflow Obstruction, Dyspnoea and Exercise capacity (BODE index). The intervention will be finished by the end of May 2014.

### RESULTS

Subjects were initially classified as COPD level  $1.6 \pm 0.7$  (low to moderate). The results of the initial assessment were

PWV  $7.6 \pm 0.6$  m/s; systolic and diastolic blood pressure  $136.9 \pm 23.0$  mmHg and  $78.6 \pm 9.2$  mmHg respectively; total walking distance  $278.2 \pm 102.5$  m; pulmonary function FVC  $73.2 \pm 11.4$  %; FEV<sub>1</sub>  $64.6 \pm 18.4$  %; FEV<sub>1</sub>/FVC  $0.65 \pm 0.13$ ; and basal heart rate  $75.5 \pm 9.7$  bpm.

### DISCUSSION

Baseline PWV was lower than other studies (3) and this value is expected to be reduced significantly ( $\pm 11\%$ ) as in other studies (1). Reductions in systolic and diastolic blood pressure are also predicted according to Vogel et al., (4). An improvement is also expected in walking distance ( $\pm 20\%$ ) similar to the data obtained by Vivodtzev et al., (4). Pulmonary function could be increased by 0-10%. If the results are as expected, it could be argued that an exercise program involving strength + HIIT exercise bouts could improve arterial stiffness according to Vivodtzev et al. (1) and Vogel et al. (4), taking into consideration that these authors focused their training programs on either endurance or HIIT. These estimated results would improve patients' quality of life.

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## EVALUATING LONG TERM FUNCTIONAL OUTCOME AND FATIGUE RELATED EFFECTS AFTER ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION

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### INTRODUCTION

ACL reconstruction (ACLR) operation aims to restore stability to allow return to sport. However, patients often still have functional deficits even after the rehabilitation and do not successfully return to their pre-injury sport level (1). The purpose of this study is to identify lower extremity performance deficits in patients after ACLR by applying the most common objective functional test: the single-leg hop test. The effect of fatigue (2) on lower extremity functional performance is also investigated.

### METHODS

Approval for the study was obtained (Leeds East PR Committee). Nineteen patients (age=32.2±6.6; years from surgery=4.91±1.8) after ACLR were tested. First, in pre-fatigue conditions, the patients were asked to stand on the test leg and then hop as far as possible and land on the same leg, three times each leg. The uninjured leg was used as control with respect to the injured leg. Then, the patients underwent a fatigue protocol consisting on repetitions on a leg press machine. Finally, participants executed the hop test as before (post-fatigue). Means and standard deviations were calculated. Paired *t*-tests were used to determine if significant differences occurred. Data were normally distributed.

### RESULTS

Pre-fatigue: hop-length for the injured leg was 117.0±24.6 cm; 123.1±22.5cm for the un-injured. Mean difference be-

tween legs was 6.1cm; ( $p < 0.004$ ). Post-fatigue: hop-length for the injured leg was 103.6±23.4cm; 109.1±20.9cm for the uninjured; mean difference was 5.5cm; ( $p < 0.014$ ). LSI (low symmetry index) was 94.87±7.30 pre-fatigue and 94.53±9.62 post-fatigue ( $p = 0.873$ ). 79% of the patients obtained normal LSI (3) pre- and post-fatigue (LSI > 90).

### DISCUSSION

Significant differences were observed between legs in both pre- and post-fatigued situations. However, most of the patients present normal LSI. An acceptable LSI of >90% may not be demanding enough. By increasing the acceptable LSI level to 95% or 100%(1), only 37% and 21% patients obtained normal LSI, respectively, so the results are considered poor (after fatigue, 42% and 16% respectively). In conclusion, consideration of the LSI for evaluating the effects of rehabilitation requires further study. Hop performance must be presented as both absolute values and the LSI (1). Fatigue does not affect the performance for this test, which is not consistent with previous studies (2).

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## RELATIONSHIP BETWEEN DIFFERENT FITNESS TESTS AND COGNITION IN PEOPLE WITH MILD COGNITIVE IMPAIRMENT

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### INTRODUCTION

Amnesic Mild Cognitive Impairment (a-MCI) is usually considered a transitional phase between normal aging and Alzheimer's disease (Petersen, 2004). There is increasing evidence about the benefits of fitness for cognition in people with a-MCI, but many questions remain open. The aim of this study was to explore the baseline correlations and power of prediction of different fitness tests with cognitive measurements in this population.

### METHODS

Forty-one people diagnosed by trained neurologists with Amnesic Mild Cognitive Impairment, according to Petersen (2004) criteria, were recruited from the Neurology Unit of the Hospital de San Vicente del Raspeig (Spain). Fitness tests included the 6 minutes walk test (6MWT), the 8-meter walk test (speed of gait), the timed get up and go test (TGUG), and the Chair-Stand test (CST). Cognitive measurements included the Mini Mental State Examination (MMSE), the Adas Cognition, the Thurstone's Word Fluency Test, and the CERAD for visual memory. Partial correlations and a stepwise linear regression model were used in order to explore baseline associations between fitness tests and cognitive measurements.

### RESULTS

Partial correlations controlling for age, gender and education showed an inverse relationship between speed of gait

and the MMSE ( $p < 0.05$ ), and visual memory ( $p < 0.005$ ); as well as a positive correlation with the Adas-Cog. ( $p < 0.01$ ). The Chair Stand Test showed a positive correlation with the Thurstone's Word Fluency Test ( $p < 0.05$ ). When a regression model was applied, speed of gait remained as a predictive variable for the MMSE ( $F = 8.549$ ; Anova  $p = 0.000$ ;  $R^2 = 0.445$ ;  $\beta = 0.375$ ;  $p = 0.01$ ), and the Chair Stand Test remained as a predictor variable for the Thurstone's Word Fluency Test ( $F = 9.149$ ; Anova  $p = 0.000$ ;  $R^2 = 0.495$ ;  $\beta = 0.385$ ;  $p = 0.007$ ).

### DISCUSSION

Exercise seems to be a promising strategy for improving cognitive function in people with MCI (Lautenschlager et al. 2008), although the number of studies is limited and the association between different field fitness tests and cognition has not been fully explored. In our study the fitness tests that best correlated with cognition were gait speed and the Chair Stand Test. Exercise interventions should consider incorporating these tests to evaluate the outcome of the programs.

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## CAN A SESSION OF HYPOPRESSIVE EXERCISES PROVIDE ACUTE EFFECTS ON FITNESS TRAINERS?

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### INTRODUCTION

Hypopressive Exercises (HE) has been created by Dr. Caufriez for postpartum physical therapy (1) and is popular for their possible effects on abdominal and pelvic floor muscles (2) and perineal dysfunctions (3). Acute effects performed by physically active women showed changes in waist circumference and extensibility of the lumbar spine (4). Therefore, the purpose of this study was to investigate the immediate effects of one session of dynamic HE on different anthropometric and physical parameters on fitness trainers.

### METHODS

Was designed a study with evaluation before (pre) and immediately after a twenty-minute HE Dynamic protocol (post), for a group of fitness trainers already familiar with hypopressive technique. Sample consisted of  $n=19$ , [36.6 years old ( $SD=6.0$ )]. A pressure biofeedback device and a peak flow meter were used to measure abdominal hollowing maneuver and peak expiratory flow, respectively. Thoracic amplitude and waist circumference were also assessed. Variables were analyzed using multifactorial analysis of variance (ANOVA) and statistical adequacy of the fitted models was evaluated using the graphical analysis of residuals.

### RESULTS

Significant differences ( $p<0.001$ ) were found for waist circumference [81,21 (0,26); 78,89 (0,26) cm], abdominal hollowing maneuver [65,89 (0,86); 60,06 (0,91) cm], thoracic amplitude [6,21 (0,71); 8,33 (0,71) cm] and peak expiratory flow (491,87 (5,60); 519,37 (5,60) L/m).

### DISCUSSION

The results suggest that it's plausible to expect acute changes in waist circumference, thoracic amplitude, peak expiratory flow, and abdominal hollowing maneuver after a workout of dynamic HE performed by fitness trainers. Similar results were provided on waist circumference (4). In this study acute effects occurred on thoracic amplitude and expiratory flow with a single workout. Probably such changes may be due to intermittent apneas of the respiratory hypopressive technique. Transversus abdominis is mainly activated during abdominal hollowing, during HE deep muscular abdominal activation is observed (2). This could be related with the results on waist circumference and abdominal hollowing suggested by the present study.

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## EFFECT OF ACUTE EXPOSURE TO MODERATE ALTITUDE ON THE MUSCLE CONTRACTILE PROPERTIES MEASURED BY TENSIO-MYOGRAPHY

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### INTRODUCTION

There is controversy regarding the neuromuscular responses occurring at hypoxic conditions. It has been suggested that hypoxia could create an advantageous environment to improve fast fibre type muscle recruitment. Different neuromuscular assessment techniques have been applied, coming up with contrasting results. Tensiomyography (TMG), a non-invasive indirect measurement of muscle contractile characteristics, has been employed in the detection of muscle fatigue, fibre composition and muscle adaptive processes. The aim of this study was to investigate the TMG capability to detect changes in the muscle contractile properties, following an acute exposure to moderate altitude.

### METHODS

Biceps femoris and vastuslateraliscontractile properties were assessed on 18 elite taekwondo athletes (age 20.1±6.1 yrs; weight 65.38±13.94 kg) at sea level and moderate altitude (2320 m) by using TMG. Measurements were recorded through single twitch electrical stimuli (1 ms duration) at several intensities (40, 60, 80 and 100 mA). TMG analysis included maximum radial displacement of muscle belly (*Dm*), time of contraction (*Tc*), activation time (*Td*) and maximum contraction velocity (*Vc*) in both, normoxic and hypoxic conditions.

### RESULTS

When vastus lateralis was assessed in hypoxia, *Dm* was lower at 40 mA (4.6±2.01 vs 5.1±2.12 mm; p=.008; ES=-.237) but non-significant differences were found at higher electric stimulations. (P≥.05). *Vc* was significantly lower under

hypoxia only after 40 (171.62±80.94 vs 199.52±73.01 mm/ms; z=-3.010; p=.003, ES=-.77) and 60 mA (236.75±98.19 vs 255.5±91.49 mm/ms; z=2.16, p=.047, ES=-.51) stimulation frequencies. *Tc* was always longer at altitude compared to sea level, significantly different when stimulating at 40 (27.93±6.09 vs 24.72±5.31 ms; z=2.15, p=.031, ES=.56) and 100 mA (25.22±3.51 vs 23.4±3.71 ms; p=.03, ES=-.51). *Td* was also longer at altitude than sea level in all stimulations employed (P<.05, ES≥.33). Biceps femoris TMG data analysis revealed lower *Dm* and *Vc* in all electrical stimulations employed when compared with sea level measurements (*Dm*: P<.001, ES>0.61; *Vc*: P<.001, ES>.55). No significant differences were found in *Tc* (P>.05, ES>-.19) and *Td* values (P>.05, ES>0.11).

### DISCUSSION

The main outcome of this study is that TMG appears to be effective at detecting changes in the muscle contractile properties at hypobaric acute hypoxia. Slower contraction velocities, smaller radial muscle displacements and greater times of contraction seem to reflect an altered muscle profile when acutely exposed to moderate altitude. However, varying responses were observed depending on the muscle assessed and the electrical current employed. Further research involving TMG will provide a better insight into the changes occurring in the muscle contractile properties during acute and chronic exposures to altitude.

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## DOES HYPOPRESSIVE TECHNIQUE AND PILATES INCREASES THE ACTIVITY OF THE STABILIZING CORE MUSCLES?

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### INTRODUCTION

Pilates (abdominal hollowing techniques) and hypopressive techniques are used for activating deep abdominal musculature and cause low compressive spine stress (Richardson & Jull, 1999). The aim of this study was to investigate surface electromyographic (EMG) activity of the rectus abdominus (RA) and internal oblique abdominus (OI) muscles during abdominal-hollowing (AH) and hypopressive technique (HT) exercises performed in on supine position with legs and knees bent at 90° (Bjerkefors A, 2010).

### METHODS

Ten healthy female participants, aged  $31.4 \pm 4.92$  years, were recruited to the experiment. Participants performed a maximal voluntary contraction (MVC) of abdominal muscles (OI and RA) during 5 s where muscle activity was recorded employing surface electromyography (EMG). EMG data of each muscle during the AH, HT were normalized as a percentage of the MVC.

### RESULTS

The results showed significant differences in EMG activity between OI and RA for the two exercises ( $p < 0.05$ ). The HT task produced lower activation of RA than AH ( $p = 0.042$ ), on the other hand. The AH technique produced an increase around 20% of the MVC in OI EMG levels compared to HT.

### DISCUSSION

The results suggest that the performance of AH and TH on the supine position with legs and knees bent at 90° can facilitate OI activity with minimal activity from RA. Similar results were obtained by Richardson et al. (1995) and Bjerkefors et al. (2010). These exercises can be used in lumbo-pelvic stability programs and for working with low superficial muscles activation (Hodges, 2003).

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## EFFECTS OF USING A COOL VEST IN THE NEUROMUSCULAR FUNCTION ON SPECIFIC SOCCER ACTIONS

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### INTRODUCTION

Soccer is a high intensity sports time that involves two 45-minute halves with a 15-minute break at half time. Player's performance is affected due to physiological factors among others. The ability to complete explosive actions such as sprints and jumping is reduced throughout the match[1]. Nevertheless all these signs will spread during the last 15 minutes of the match, some studies suggest a decrease of intensity level on the initial 15 minutes of the second half compared to the first half. High core temperature is an element that seems to reduce the capacity to perform high intensity exercises and mid-long duration endurance activities[2-4]. Body cooling is a method which could beneficiate cardiovascular system, metabolism and on the central and peripheral nervous system changing sensorial feed-back of thermoregulation system[5, 6]. This encourages the idea that in team sports like soccer, this method could be interesting applied during match's half time to recover strength baseline levels. The purpose of the present study was to investigate the effects of a cool vest used as a cooling method during the half part of a match within the neuromuscular function of soccer players.

### METHODS

Nineteen football players participated. A repeated-measures design was used. Participants completed the FIFA 11+ warm up. After that, three randomly assigned neuromuscular tests, such as Countermovement Jump (CMJ), 30-meter sprint, in which maximum peak velocity and the final time were recorded and a shot speed test, consisting in a shot to a goal at a 2 meter, considering that more distance could be detrimental to shot power, were measured. Then an intermittent protocol was undertaken employing 5 repetitions of 9 minute bouts of different running speeds on a motorized treadmill based on an adapted study of Spanish soccer players match analysis [7]. After the intermittent protocol the participants remained seated resting for 15 minutes simulating soccer half time. Recovery involved either no cooling or the application of the cool vest.

### RESULTS

We observed a fatigue-induced effect on all three neuromuscular test outcomes conducted from baseline values to post-exercise values, decreasing 30m sprint, CMJ and Shot

Speed abilities performance. No significant differences were found except for the Shot speed test ( $p=0.043$ ) from cool vest group in which the outcomes were better than the baseline test. We also observed that cool vest group had less reduction of tests outcomes than control group.

### DISCUSSION

The effects of the cool vest as cooling method during the recovery time did not significantly maintain or improve the baseline values of neuromuscular tests we applied, compared with control group. Reduction of baseline outcomes in sprint ability and CMJ corroborated the results of others studies [8, 9]. However, slightly better values were found in cool vest group[10, 11] compared with control group and their baseline results. Furthermore, applying during more time the cool vest or until as close as possible to the exercise should be more beneficial for endurance and sub-maximal activity like soccer. The ergogenic benefits of effective cooling procedures for team-sports neuromuscular activities are not significantly maintained compared with control group and baseline values.

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## BE FIT AND SMART: TEAM SPORTS PRACTICE IMPROVES PHYSICAL FITNESS, SUSTAINED ATTENTION AND ACADEMIC ACHIEVEMENT IN ADOLESCENCE

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### INTRODUCTION

The interest on the relationship between sport practice, physical fitness, and cognitive processing is increasing in recent years<sup>1</sup>. Here, we focused on team sports practice as a key factor involved in fitness level, vigilance (i.e., the ability to maintain focused attention) and academic achievement in male and female adolescents.

### METHOD AND DESIGN

Two groups of participants (N=75) were selected on the basis of their team sports (football) training habits. Participants were evaluated in two separate sessions (1<sup>st</sup> session: Vigilance Task; 2<sup>nd</sup> session: Leger Multi-stage fitness test). In addition, a brief anthropometric assessment was conducted to obtain their body mass index and the academic achievement was annotated.

### RESULTS

**Physical fitness:** Time-to-exhaustion (TTE) data revealed a main effect of Training ( $p < .001$ ), and Sex ( $p < .001$ ), with larger TTE values for the trained than for the untrained group, and for males than for females participants. **Cognitive processing:** Reaction time (RT) data showed a main effect of Training ( $p < .001$ ), with trained participants responding faster than untrained, and a main effect of Time on task ( $p < .01$ ), with participants responding slower as the time on task increased. The analysis on the number of lapses ( $RT > 500\text{ms}$ ) revealed a main effect of Time on task ( $p < .001$ ), with the number of lapses increasing as time on task went by, a significant main effect of Training ( $p < .001$ ), with trained participants committing fewer lapses than untrained, and a significant interaction between Time on task and Training ( $p = .04$ ), with the vigilance decrement being more pronounced in untrained than in trained participants. **Academic achievement:** Academic performance was better in trained than untrained group ( $p < .001$ ).

### DISCUSSION

Results confirmed our predictions with trained participants showing improved physical fitness and vigilance performance (faster responses, fewer lapses and seemed to be less prone to vigilance decrement over time) than untrained. More importantly, football players also resulted in improved academic performance. The present study revealed the impact of team sport practice on achievement an all-around development of the adolescent. In line with previous studies, we suggest that physical fitness might be an important factor to explain the differences in cognitive performance.

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## SEQUENCING TRAINING AND PERFORMANCE IN RHYTHMIC GYMNASTICS

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### INTRODUCTION

In competitive periods rhythmic gymnastics training demands a great amount of repetitions of the competitive exercises. In order to maintain an optimal performance level that best helps gymnasts to achieve highest results, it is desirable to control the training pattern referred to the sequencing of the exercises. Little has been brought about in scientific literature (2). High volumes in hours of training predict best performance (1). However highest training loads are not always effective, and there is a need to establish a correct pattern of training load and intensity according to the fitness level of the gymnasts (4). Pre-competition warm up intensity is highest in elite than sub-elite gymnast that perform a fewer amount of routines (3). The objective of the study is to correlate de sequence: number and order of execution of competitive exercises and the scores achieved: total points, execution points and difficulty points.

### METHODS

Eighth National level gymnasts, junior and senior, with more than 8 years of experience participated. During 12 weeks previous to Nationals, and in every training sesión they performed a pattern of 10 repetitions of the competitive routine. According to the order of performance each exercise was given a sequence value: 1<sup>st</sup>, 2<sup>nd</sup>, and so up to 10<sup>th</sup>. Two international expert judges evaluated for difficulty, execution and final score.

### RESULTS

The highest final, execution and difficulty scores are obtained in exercise 5<sup>th</sup>, followed by 4<sup>th</sup> and 3<sup>rd</sup>. The lowest values correspond to exercises 9<sup>th</sup> and 10<sup>th</sup>, both in final and partial scores.

### DISCUSSION

These data suggest that the gymnasts need to perform a minimum of four exercises repetitions before achieving their best performance score, getting worse as it progresses the number of exercises performed, possible consequence of the onset of fatigue. Sequencing the exercises and identifying best performance patterns could contribute to design competitive training loads and competition warm-up strategies.

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## CRITERION AND CONCURRENT VALIDITY OF THE 7 DAY-PAR IN SPANISH ADOLESCENTS

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### INTRODUCTION

Valid measures of physical activity (PA) are necessary to generate rigorous knowledge in the field of PA and health (1). This study analyses the validity of the self-report questionnaire Seven Day Physical Activity Recall (7 Day-PAR) (2) in Spanish adolescents. For this purpose, we analysed the relations of 7 Day-PAR data with accelerometer data (concurrent validity) and with the aerobic physical fitness and body fat percentage of the sample (criterion validity).

### METHODS

The study was carried out with a sample of 123 Spanish adolescents ( $M = 14.85$ ;  $SD = .87$ ). Physical activity was measured by the 7 Day-PAR and the GT3X Actigraph accelerometer. Aerobic fitness was estimated by the 20-m shuttle run test. Body fat percentage was measured using a bioelectrical impedance scale (Oregon Scientific GR101).

### RESULTS

Correlations of “moderate” and “hard” PA (7 Day-PAR) with “moderate” and “vigorous” PA (accelerometer) were low ( $r = .25$ ,  $p < .01$ ; and  $r = .18$ ,  $p < .05$ , respectively). “Very hard” PA (7 Day-PAR) showed a higher correlation with “vigorous” PA (accelerometer) ( $r = .38$ ,  $p < .05$ ). “Very hard” PA (7 Day-PAR) and “vigorous” PA (accelerometer) negatively predicted body fat percentage ( $b = -.29$ ,  $p < .01$  and  $b = -.45$ ,  $p < .01$ , respectively), and positively predicted aerobic fitness ( $b = .41$ ,  $p < .01$  and  $b = .51$ ,  $p < .01$ ). However, “moderate” PA (7 Day-PAR) positively predicted body fat percentage ( $b = .20$ ,  $p < .05$ ).

### DISCUSSION

The 7 Day-PAR showed acceptable validity for the measurement of “very hard” PA and low validity for “hard” PA. This questionnaire showed a problem in the measurement of “moderate” PA, since previous studies have pointed out that “moderate” PA is negatively related to body fat percentage (3). “Moderate” PA collected by self-report methods is likely to be underestimated (4). It seems that young people find it difficult to report their time in “moderate” PA properly, because it tends to be more sporadic, non-planned, and therefore less memorable and quantifiable than high-intensity activities (4).

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## METABOLIC POWER IN TENNIS: NEW APPROACH TO UNDERSTAND THE PHYSICAL DEMANDS

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### INTRODUCTION

Tennis is characterized by high intensive work periods interspersed with moderate long and rest periods (1). However, these researches did not analyse the speed of movements or accelerations. Due to small size tennis court, it is more important to analyse the accelerations than tennis players' speed. Recent research from different sports have been analyzed the activity demands of training and match-play (2,3). These demands are based on theoretical model that allows the estimation of the energetic cost of accelerations and decelerations, it is called as metabolic power.

### METHODS

Seventeen female and twelve male young high-level tennis players (Spanish Tennis Ranking) took part in the study (mean age: 14.0 ± 2.9 years). They were members of different age divisions (beginners: 11-12 years; youth: 13-14 years; teenager: 15 years; and junior: 17-18 years) in High Level Performance Centre of Aragon Tennis Federation. They had been playing between 3 and 5 years in high-level competition and at present they are in the first places of the ranking. All tennis players were tracked from 1 to 3 matches (n=87). Data were collected using eleven portable GPS devices (MinimaxXv.4.0, Catapult Innovations) operating at a sampling frequency of 10 Hz. The analyzed variables were: energy average metabolic power (AVG>0, AVG>10, AVG>20, AVG>35, AVG>55 all in w/kg), total energy expenditure (ENG), estimated distance (ED), equivalent distance index (EDI) and metabolic efforts (EE>10, EE>20, EE>35, EE>55, all in w/kg). 12 Reliability and accuracy of the devices used in this study had been assessed in short distance exercises (4).

### RESULTS

Metabolic power data could be a useful variable to determinate tennis players' physical demands and sensitive indicator to compare among them. The greater part of distance covered by tennis players was realized during accelerations and decelerations (89.2%). Besides, tennis

players' metabolic power depends on qualifying round in tennis tournament and ranking of players. Metabolic power demands in final round were higher than in quarter-final round (EE>10 W/Kg; p=0.03). Higher ranking players developed higher metabolic power demands in final round than lower ranking players (HR=17.8 vs. LR=13.7 KJ/Kg; p= 0.14). However, lower ranking players developed higher metabolic demands in quarter-final round than higher ranking players (HR=14.0 vs. LR=16.6 KJ/Kg; p= 0.22).

### DISCUSSION

To the authors knowledge the present investigation represents the first attempt to quantify the metabolic power values to tennis players in match-play. Recent research in tennis had analyzed metabolic parameters such as: Vo<sub>2</sub>, lactate or heart rate (5,6) However, these research did not analyzed metabolic costs of tennis players. In relation, there were some research which had analyzed the metabolic cost of soccer players (2,3). These researches concluded that metabolic power data contribute to a better knowledge about the physical demands or external-load in tennis players. This is a previous step to adequate training load that simulating matches' demands.

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## TEST-RETEST RELIABILITY OF MAXIMAL 750M FREESTYLE ENDLESS POOL SWIMMING

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### INTRODUCTION

Elite triathletes obtain similar physiological values as single-sport athletes despite training time divided among three disciplines (1). Yet researchers have long expressed the need to develop experimental protocols capable of replicating the sequential demands of the sport to investigate different training and nutritional interventions on triathlon performance (2). The swim component of triathlon testing is typically undertaken in a 25 or 50m pool with swimmers performing numerous turns to achieve the required test distance. Turns have a deceleration and acceleration component not present in open water triathlon swimming. Additionally, fixed length pools are often not in close proximity to cycling and run test facilities. An alternative approach is to utilise an easily re-locatable swimming flume (Fastlane pool™, Endless swimming pools, USA) however to our knowledge there are no published studies reporting the test-retest variability in athlete swim times using this method. The objective of this study is to report the athlete test-retest reliability of simulating the swim of a sprint triathlon in fast-lane pool.

### METHOD

Fifteen age-group swimmers or triathletes of various abilities provided written informed consent to participate. Two maximal 750m fastlane swims were undertaken a week apart, during which stroke rate and pace were recorded while distance was calculated using pace/time tables. Swim pace was increased or decreased accordingly by the

tester (using a remote control) based on the swimmers ability to keep up with the water flow. Post swim heart rate, lactate and perceived effort values were also recorded. The pool temperature was kept at 26°C, and the study was approved by an institutional ethics committee.

### RESULTS

The reliability of competitive performance of athletes provides an estimate of the smallest worthwhile change in performance. Our within athlete typical variation results will be compared against the reported 1.2% typical within athlete race to race variation in the swim component for the top 10% of triathletes (3).

### DISCUSSION

In comparison to actual competition, simulated sport performance provides better reliability to experimentally assess a particular intervention. The current data should be utilised by researchers interested in comparing the test protocol benefits and logistics of using a swimming flume versus a traditional swimming pool to test triathletes and assess factors that affect triathlon swim performance.

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## SIMILAR EFFECTS OF TWO EQUATED CONCURRENT TRAINING PROGRAMS: ACSM RECOMMENDATIONS vs. A POLARIZED INTENSITY DISTRIBUTION

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### INTRODUCTION

Previous studies have suggested the greater effectiveness of concurrent endurance and strength training when compared to strength and endurance training alone (1). However, there are no studies comparing concurrent training programs with different intensity distribution and equated loads. Thus, the aim of this study was to compare a concurrent training based on ACSM guidelines (2) with a concurrent training of equated load but with polarization of training intensities.

### METHODS

After a 2 week-familiarization period, 31 sport science students were randomly distributed into 3 groups: concurrent training based on ACSM guidelines (AT), concurrent polarized training (PT), and control group (CG). Before and after 8 weeks of training with a frequency of 3 days a week, participants were evaluated on: resting heart rate variability (HRV), countermovement jump (CMJ), maximum aerobic speed (MAS), and estimated repetition maximum (RM) in bench press and half squat. AT performed running training at 65-75% of MAS, combined with resistance training (RT) at 10-12RM. PT performed brisk-walking at 35-40% of MAS and sprint training at 120% of MAS, combined with RT at 5RM and 15RM. The training loads of both experimental groups were externally equated. Pre-post and between groups differences were evaluated via analysis of variance (ANOVA). Cohen's *d* was also calculated for effect size (ES). Thresholds for effects were: 0.20 "small", 0.50 "medium", and 0.80 "large". The level of significance was set at 0.05.

### RESULTS

AT and PT significantly improved MAS (ES: 0.37 and 0.36, respectively), and estimated RM in bench press (ES: 0.73 and 0.78, respectively) and in half squat (ES: 1.42 and 1.39, respectively) after the training period. Further, both AT and PT showed significantly higher half squat estimated RM in post-evaluation than CG (ES: 1.76 and 1.78, respectively). AT and CG significantly reduced CMJ height in post-evaluation (ES: 0.39 and 0.72, respectively), while HRV was not significantly altered after the training period in any group.

### DISCUSSION

The main finding of the current study is that a concurrent training with polarized intensity distribution exhibited similar improvements on both cardiorespiratory and musculoskeletal fitness when compared to a concurrent training based on ACSM guidelines (2), although vertical jump performance was only maintained after the training period in PT. While these training programs were performed three days a week, it is still unknown how differences between programs would become evident with more training sessions per week and after a longer training period. The current results suggest the effectiveness of equated concurrent training programs of different training intensity distributions and moderate volume in physically active individuals.

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## EFFECT OF RUNNING SURFACE AND FATIGUE STATE ON IMPACT ACCELERATION IN LONG-DISTANCE RUNNING

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### INTRODUCTION

Running on a treadmill provokes biomechanical modifications in running gait such as differences in stride frequency, contact time, ankle, knee and hip kinematics, muscle activity, energy expenditure or shock attenuation (1,2). Shock attenuation and the severity of the impact acceleration are two of the most important variables analysed in running research due to their hypothetical relationship with potential injury. While the differences between treadmill and overground running would seem to cast doubt on their equivalence as running surfaces, many authors nevertheless consider that running on a treadmill may be a representative expression of running overground. This study thus examined the effects of treadmill running on impact acceleration and the interaction between running surface and the runner's fatigue state.

### METHODS

Twenty runners ran on a treadmill and overground (4m/s) before and after a fatigue protocol (30-min run at 85% of their individual maximal aerobic speed). Impact accelerations (tibia and head peak acceleration, tibia and head rate of change of acceleration [impact rate] and shock attenuation) were analysed by placing accelerometers on the runners' shank and forehead.

### RESULTS

In pre-fatigue condition, running on the treadmill reduced head and tibial peak impact acceleration and impact

rate compared to overground running, but no differences were observed between surfaces in shock attenuation. Moreover, no difference in acceleration between surfaces in post-fatigue condition was observed. There was a significant interaction between surface (treadmill vs overground) and fatigue state (pre-fatigue vs post-fatigue).

### DISCUSSION

An altered environment such as running on a treadmill may force the runner to make adjustments in gait to maintain their performance or reduce the risk of injury (3), what could lead to modifications in the forces and accelerations experienced by the runner. The alterations in impact accelerations observed when running on the treadmill under no fatigue may indicate that running on a treadmill could also affect other relevant running parameters. Moreover, when running overground, fatigue reduced impact acceleration severity, but had no such effect when running on a treadmill. Thus, the effects of treadmill running and the interaction between running surface and runner's fatigue state need to be taken into account when interpreting the results of studies that use a treadmill in their experimental protocols and when designing sport equipment and prescribing physical exercise.

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## INITIAL FOOT CONTACT AND CENTRE OF PRESSURE DURING WALKING AND RUNNING: IMPLICATIONS ON RUNNING PERFORMANCE

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### INTRODUCTION

Foot's centre of pressure trajectory (CoPT) analysis plays a fundamental role in establishing the biomechanical patterns (1). Although walking and running biomechanics have been widely investigated (2, 3, 4), further studies have not been undertaken on the evaluation of these parameters at a personalised speed on the basis of a maximal running test.

### METHODS

48 moderately trained participants were divided into 3 groups, according to running performance: highly-trained runners (HTR), middle-trained runners (MTR), and control (CON). Participants were assessed in: anthropometric characteristics, maximum aerobic speed (MAS), walking and running at individualised speed (i.e. 55% of the threshold speed between walking and running and 85% of MAS, respectively) in both barefoot and shod conditions, in order to study the initial foot contact (IFC) and CoPT. Same type of running shoes with homogeneous lacing pattern was worn, and the biomechanical analysis order was randomised. Between-group and biomechanical conditions differences were tested via analysis of variance (ANOVA). The significance level was set at 0.05.

### RESULTS

HTR reached a higher MAS (mean (SD): 19.86 (0.68) km/h) than MTR (mean (SD): 18.47 (0.48) km/h) and CON (mean (SD): 16.6 (0.97) km/h) ( $p < 0.001$  for both). Further, MTR got a higher MAS than CON ( $p < 0.001$ ). Time percentage of a total foot roll-over (FRO) when walking barefoot, compared to shod condition, was shorter in the transition from heel contact to first metatarsal con-

tact, and from heel off to push off in all groups ( $p < 0.05$  for all comparisons). Conversely, this percentage was higher when walking barefoot in the transition from flat contact to heel off in all groups ( $p < 0.05$  for all comparisons). Total time for FRO when running barefoot was quicker compared to shod condition in HTR and MTR ( $p < 0.01$  for both). Moreover, HTR and MTR showed a quicker total time for FRO when running than CON in both barefoot ( $p < 0.001$  and  $p < 0.05$ , respectively) and shod ( $p = 0.001$  and  $p < 0.05$ , respectively) conditions. The prevalence of forefoot IFC when running, in both barefoot and shod conditions, was higher in HTR (44.4% and 38.9%, respectively) than in MTR (33.3% and 26.7%, respectively) and CON (13.3% and 0%, respectively).

### DISCUSSION

Our results show that forefoot IFC becomes more evident when the athlete's performance increases, as previously demonstrated (4). The shorter duration of FRO in the barefoot compared to shod running condition could be due to a more natural and anterior IFC. Therefore, according to previous studies (2, 3), running shoes might determine walking and running biomechanics in trained endurance runners.

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## REGENACTIV® TECHNOLOGY ASSESSMENT IN SOCKS FOR NORDIC WALKERS

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### INTRODUCTION

There is strong evidence that confirms that physical activity provokes numerous benefits for the human health. However, physical activity may also lead to injuries or illnesses in specific areas of the body such as the feet. Some of these injuries are believed to be related to the interaction of the foot with the shoe and sock (Blackmore et al., 2011), as well as the skin hydration status. One way to prevent these injuries is the use of new fibers to develop textile materials (Pérez et al., 2007). In this sense, the objective of this study was to determine the influence of the socks "Regenactiv®" in the perception of comfort, and their contribution to the hydration level in the foot during physical activity, specifically Nordic walking.

### METHODS

This study involved a total of 57 volunteers (12 male and 45 female [63.7 ± 2.5 years, 69.5 ± 8.6 Kg, 1.6 ± 0.11 m]) who walked at least 1h/day, three days/week during a month, and were free of injury and pain in their lower extremities so that their normal gait pattern would not be modified. A questionnaire was used to evaluate the hydration perceived comfort, through the variables "Height", "Adaptability", "Abrasions", "Temperature" and "Comfort". For the assessment of hydration, a skin hydration meter Hydrosensor (Microcaya, SL) was used. This instrument

displayed a valuation from 1 to 10. The hydration measures were taken at five foot zones: "Heel", "Midfoot", "Head of fifth metatarsal", "Head of first metatarsal" and "Instep central zone".

### RESULTS

The results showed significant improvements in two of the analyzed comfort variables: Comfort and Adaptability (~ 10%), and levels of hydration in the metatarsal heads of the 1st and the 5th toe (~ 9%). Discussion: In this study, the sock textile properties were analysed in order to find out their possible effect on physical activity. The sock Regenactiv® showed a significant increase in comfort and adaptability compared to the placebo socks, which can positively influence healthy physical practice. In terms of hydration, there was a significant increase, particularly in the head of the 5th and 1st metatarsals (9.1% and 8.3%, respectively). In conclusion, these types of socks can be a relevant element which may play an important role in the prevention and care of foot injuries.

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## IMPACT OF LOW TO HIGH INTENSITY OF RESISTANCE TRAINING PROGRAM IN ENHANCING LEG STRENGTH AMONG MALES

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### INTRODUCTION

Leg strength is very essential for sports persons, and especially for athletes. Leg strength is the capacity of the lower limbs to exert muscular force (Baumgartner and Jackson, 1991), (3). A Study pertaining to two days of training per week had shows improvement in the strength (Bell, 1990, Faigenbaum et al., 2002), (2,6). The purpose of this study was to investigate the impact of low to high intensity of resistance training program in enhancing leg strength among untrained males.

### METHOD

A group of (N=30) untrained subjects were selected randomly for this study from the various classes of physical education college course, age of the subjects between 18-22 years. The training program was employed for 12 weeks, five resistance training exercises considered for the legs, 25 minutes of training per session, two days of training per week. The selected leg strength test considered for this study was sitting calf raises, standing leg curls, adductors, abductors, and leg extensions. The scores were recorded in kilograms. To find out the mean differences from pre to post test, mean, S.D and t-tests were computed by means of Statistica Software.

### RESULTS

The analyzing of data reveals that the mean and standard deviation with regard to sitting calf raises performance among training group from pre to post test were (25.70, 12.70) and (64.83, 14.59) increased by 39%. Standing leg raises with mean and S.D were (23.12, 7.86) and (45.87, 14.92) increased by 50%. Abductor exercise with mean and S.D were (59.50, 13.86) and (109.83, 23.14) increased by 54.17%. Adductors with mean and standard deviation were (61.40, 25.27) and (113.10, 26.08) increased by 54.29%. Leg extension exercise with mean and S.D were (29.17, 15.43) and (49.80, 16.37) increased by 58.57%.

### DISCUSSION

Twelve weeks of low to high resistance training program have a significant effect in enhancing leg strength among

males. Similar results were obtained Hawkins and et.al, (2009) indicate that the high velocity and high force training programs on untrained college males, consisting of weight lifting, plyometric, improved the lower body performance, especially in the area of jump height and power (4). In the present study the selected college males were untrained and their scores were very low in the pre test pertaining to all the selected resistance exercises for the lower body. In the post test the participants had shows an improved performance in enhancing leg strength in all the selected resistance exercises.

### CONCLUSION

It was concluded that the impact of low to high resistance training program in enhancing leg strength among the males had shows greater performance from pre to post test in all the selected exercises, which is very encouraging and significant.

### KEY WORDS

Resistance, strength, Intensity, enhances.

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## INFLUENCE OF LACK OF KNOWLEDGE ABOUT THE LOAD IN EXPLOSIVE PARAMETERS DURING BENCH PRESS THROWS

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### INTRODUCTION

Muscle capacity to generate maximal force in early phases of movements is generally accepted as an important component of sport performance and it is an important indicator of the neuromuscular system performance (1). Therefore the ability to produce higher power in the first phases of the movements should be pursued as a goal of the strength training.

### METHODS

Twenty eight physically active college students, with at least one year in bench press training, took part in the study. All subjects completed an informed consent document as approved by the Declaration of Helsinki. Participants performed 6 sets of 6 repetitions of pure concentric bench press throws with loads representing 30, 50 and 70% of their RM. In three of those sets, participants had knowledge (known situation) about the load lifted in each repetition (which was varied within the sets) and in the other three they did not have knowledge about it (unknown situation). During the protocol a rotary encoder were attached to the barbell to record data.

### RESULTS

Repetitions performed during unknown situation showed higher values of power and ratio of force development during the initial phase of the bench press (30, 50,

100 and 150 ms), and the time necessary to achieve RFD-max with 50 and 70% of 1RM was smaller. Despite these results, no significant differences were found in peak power or maximum ratio of force development when the entire movement was analyzed.

### DISCUSSION

Several studies have shown the relation between force production in early movement phases or the ratio of force development and performance in specific sport movements (2, 3). Therefore the higher power/RFD output during first moments of a bench press throws in unknown condition may indicate that this kind of stimulus (uncertainty) could be used in strength training to improve explosive parameters.

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## THE INFLUENCE OF AUGMENTED FEEDBACK AND AN EXTERNAL FOCUS OF ATTENTION ON JUMP PERFORMANCE

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### INTRODUCTION

Jump performance is essential in many sports but little is known how to optimize jump training. Thus, the aim of the present study was to investigate the effects of different parameters that enhance the quality and outcome of a training session. In Exp. 1, the short- and long-term influence of augmented feedback (aF) on drop jumps was scrutinized as previous studies investigating non-jumping movements indicated that provision of aF has the potential to enhance performance both in the short- (1) and long-term (2). Exp. 2 investigated the influence of an altered focus of attention on jump height in countermovement jumps (CMJs). Previous studies have demonstrated that instructions that direct a performer's attention externally enhance motor skill performance (3). However, the efficacies of using an external focus of attention (EF) or an internal focus of attention (IF) has never been compared with the direct effects of aF. Therefore, the aim of experiment 2 was to identify the condition (aF, EF, or IF) that leads to the highest jump heights in CMJs.

### METHODS

Exp. 1: 34 participants were assigned to three groups that trained drop jumps for four weeks with different relative frequencies of aF: 100%, 50%, or 0%. The jump height was displayed as aF. Exp. 2: 19 volunteers performed 12 series of maximum CMJs. Changes in jump height between conditions (aF, EF, or IF) and within the series of each condition were analyzed.

### RESULTS

Exp. 1: A positive within-session effect of aF on jump height was observed before and also after the training period ( $p < 0.001$ : pre +4.6%; post: +2.6%). In the long-term (comparing pre- to post-measurement), the 100% group showed the greatest increase in jump height (+14%), followed by the 50% (+10%) and the 0% group (+6%) (time\*group interaction:  $p < 0.05$ ). Exp. 2: Jump heights differed significantly between conditions ( $p < 0.001$ ) and the highest one was observed in aF ( $32.0 \pm 7.1$  cm), followed by EF ( $31.2 \pm 6.6$  cm) and IF ( $30.7 \pm 6.8$  cm).

### DISCUSSION

Exp. 1 highlights an immediate beneficial effect of aF on jump height in the pre- and post-test. The long-term results after training show that the higher the feedback frequency the higher the performance gains. The results of Exp. 2 show that providing aF is more efficient to foster jump performance than using an EF or IF. Based on these two experiments, it is recommended to include aF with a high frequency in jump training.

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## EFFECTS OF A 6-MONTH RESISTANCE TRAINING ON HEART FUNCTION AND PHYSICAL FITNESS IN STABLE PATIENTS WITH CHRONIC HEART FAILURE

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Resistance training (RT) is part of international recommendations in healthy life style in older adults, healthy population and in patients with chronic heart failure (CHF). The study of effects of RT on heart function and adaptation to this type of training is not well known. The aim of this study was to determine the effects of a 6-month-RT left ventricular (LV) function (end-systolic, end-diastolic volumes, ejection fraction) and physical fitness (treadmill test, upper and lower body strength test with linear encoder) in CHF patients with functional class II and III of New York Heart Association. To date, 5 patients (mean age  $64.2 \pm 4.4$  years; 4 men, 1 women) were enrolled and performed 45 RT exercise sessions (6 months, 2 days per week). The program was structured in aerobic exercise and six different exercises on circuit weight machines with personalized workload 75% of 1RM. Heart function

(echocardiography) and physical fitness parameters were assessed at baseline and at 6-month-followup. Results: All patients completed the training program, none presented adverse events. Modest improvements in end-systolic volume (pre:90.3 ml, post:104.2 ml) and end-diastolic volume (pre:145.8 ml, post: 159.2 ml). Ejection fraction improved 4.6% ( $p=0.019$ ); physical capacity significantly increased (pre:  $7.4 \pm 2.5$  Mets, post:  $9.0 \pm 2.9$  Mets;  $p=0.0249$ ) in the treadmill test; maximal muscle strength testing significantly increased: Vertical Chest Press 41% ( $p<0,05$ ), Press Machine Shoulder Press 44% ( $p<0,05$ ), LatPull-down 14% ( $p<0,05$ ), Seated Row 78% ( $p<0,05$ ), Leg Extension 29% ( $p<0,05$ ). Conclusion: A structured RT program improves measures of resting LV function and physical fitness level in patients with heart failure. Additional studies utilizing a great number of subjects are required.

## DOES WHOLE BODY VIBRATION COMBINED WITH ELECTROMYOSTIMULATION INCREASE BLOOD FLOW MORE THAN EACH TREATMENT ALONE?

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### INTRODUCTION

Exercise and muscle contraction provide a powerful stimulus for vascular remodeling [1]. Endothelial cells are subjected to the shear stress resulting from blood flow and are able to convert mechanical stimuli into intracellular signals that affect cellular functions[2]. Whole body vibration (WBV) has been shown to produce increases in blood flow velocity [3] without significantly stressing the cardiovascular system [4]. Otherwise, low frequency electromyostimulation (ES) induces light muscle contractions responsible for a muscle pump effect that enhances muscle blood flow [5, 6]. However, to date, no study has shown the effect of the simultaneous application of both stimuli on blood flow. The aim of this study was to compare the acute effects of isolated and simultaneously application of WBV and ES on the popliteal blood flow in healthy subjects.

### METHODS

Thirteen males were assessed in 5 different sessions. After a familiarization session subjects received 4 protocols (10 set x 1 min ON + 1 min OFF): WBV (V), ES (E), simultaneous WBV and ES (V+E), and 30s of WBV followed by 30s of ES (30'-30'). The subject was standing on the vibration platform (squat position, 30° knee flexion, 26 Hz, 5 mm peak-to-peak), and ES was applied on the gastrocnemius of both legs (8 Hz, 400 µs).

### RESULTS

A time\* protocol effect was observed in both Mean Blood Velocity (MBV) ( $p < 0.001$ ;  $\eta^2 = 0.324$ ) and Peak Blood Velocity (PBV) ( $p < 0.001$ ;  $\eta^2 = 0.297$ ). During the application of each protocol, the average increment of PBV was 55.7%, 87.3%, 110.7% and 74.2% for V, E, V+E and 30'-30', respectively.

### DISCUSSION

The simultaneously application of WBV and ES produced the greatest increase in MBV and PBV. Through increased efficiency shown, this protocol has an interesting practical application in cases in which WBV and ES was being used to produce vascular remodeling.

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## EFFECT OF SET CONFIGURATION ON BLOOD PRESSURE DURING RESISTANCE EXERCISE

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### INTRODUCTION

Resistance exercise produces a sudden increase in blood pressure (BP), so trainers should be careful when provide training in special populations. Many studies have shown that the length of the set determines the response of BP, with higher levels with each subsequent repetition and a peak occurring prior to muscular failure. In addition, larger rests between sets allow partial recuperation to previous BP values.

The aim of this study was to compare the effect of 3 lengths of the set with the same intensity and work-to-rest ratio on heart rate (HR), systolic (SBP) and diastolic (DBP) blood pressure.

### METHODS

Ten students (23.9±2.51 yr; 1.75±0.07 m; 68.74±8.92 kg; HR: 57.78±9.62 bpm. SBP: 115.95±5.9 mmHg; DBP: 68.47±4.54 mmHg) were evaluated in 3 set configurations. 10 repetitions maximum (RM) was determined twice for leg press. In a counterbalanced design, subjects realized at maximal velocity a) 5 sets of 8 repetitions with 3 mins of rest between sets (8S). b) 10 sets of 4 repetitions with 1:20 mins of rest between sets (4S) and c) 40 sets of 1 repetition with 18 sec between each repetition (1S). All protocols had the same load (10RM load), volume (40 repetitions) and total rest (720 sec). HR, SBP and DBP were obtained beat-by-beat with an electrocardiogram and a photoplethysmograph, respectively (Task Force Monitor). Mean values were calculated for groups of 8 repetitions. 2-way repeated measures ANOVA (Session x Set) was used for all criterion variables ( $p \leq 0.05$ ).

### RESULTS

For SBP, a significant interaction was observed between Session and Set ( $p=0.035$ ) with different patterns of increase depending on the protocol. No main effects were observed for the entire sessions for SBP (1S: 156.78±16.97; 4S 156.77±24; 8S 147.93±15 mmHg) nor for DBP (1S: 103.03±8.74; 4S: 103.53±14.4; 8S: 103.83±10.6 mmHg). For HR, a main effect for Session was observed, with lower values for 1S and 4S compared with 8S (101.92±13.27 vs. 107.68±11.16 vs. 125.03±12.37 bpm). Main effect of Set was significant for all variables.

### DISCUSSION

Although mean values were similar between set configurations, the interaction between Session and Set for SBP indicates that differences between sets were dependent of set configuration. Previously, Baum et al. (1) reported a decrease in BP response by using rest interval between each repetition. However, similarly to the present study, Lamotte et al. (2) did not observe differences between protocols of different length and intensity, but with similar total work and rest. This suggests that the work-to-rest ratio has a key role in pressor response when a submaximal exercise is performed.

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## EFFECTS OF DIAFRAGMATIC ASPIRATION ON PHYSICAL AND BLOOD PARAMETRES OF PROFESSIONAL MOUNTAIN BIKERS

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### INTRODUCTION

Diaphragmatic aspiration technique associated with expiratory apnea (1), called Hypopressive Technique (HT), has no evidence of its application on professional athletes. Scientific evidences suggests HT are aimed at rehabilitation of perineal pathologies (2) or spine pathologies (3). HT may reveal possible intermittent hypoxic changes in physiological parameters related to performance.

### METHODS

Was designed a descriptive study with 4 professional mountain bikers of the Galician Center of Sports High Performance (age 15.25 years). Evaluation was performed before and after a 8-week HT protocol. The first month, 2 weekly 20-minute sessions of five hypopressive exercises were performed, then daily training was followed. Were assessed: body composition (Holtain caliper and Tanita BF522); hamstring extensibility with the sit and reach test; maximum oxygen consumption (VO<sub>2</sub>), with gas analyzer on a Cardgirus ciclo simulator. Finally, complete blood analysis was assessed in medical laboratory.

### RESULTS

No significant changes were shown in the summation of folds, percent body fat and VO<sub>2</sub> ( $p > 0.05$ ). However, marked improvement in hamstring extensibility and hematological values were described ( $p < 0.05$ ).

### DISCUSSION

The present study describes changes on hemogram values. The literature shows how intermittent hypoxia training method appears to be beneficial to stimulate athlete's erythropoiesis and result an increase of athlete's performance by better oxygen carrying capacity in the blood (4). Recently has shown an improvement of athletic performance with HT (5), in athletes whose oxygen saturation during HT training revealed intermittent hypoxic. Hamstring flexibility was increased. By contrast, there were no significant change in body composition perhaps due to the low energy cost of hypopressive exercises.

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## ANALYSIS OF THE DETERMINING TRIPLE JUMP PERFORMANCE VARIABLES IN COMPETITIONS AT DIFFERENT AGES

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### INTRODUCTION

In recent years, numerous biochemical analyses have been carried out on the triple jump, some of them in major international competitions.

However, there are very few studies that have analysed and compared athletes of other age categories, from 14 to 22 years of age, in competitions. This study aims to discover whether the determining triple jump variables are the same for different age categories.

### METHODS

The finals of twelve 2013 indoor triple jump championships were analysed, in cadet (14 to 15 years of age), youth (16 to 17), juniors (18 to 19), under 23(20 to 22), and absolute category in Catalonia, as well as absolute category in Spain.

The sample consisted of 108 athletes (55 men and 53 women), whose best jump in each competition was selected for the study. The space was calibrated (runway and sand-pit) and 5 Casio EX-F1 cameras were used: 2 recording at 300 fps and 3 which recorded at 30 fps and in HD. There were 3 Microgate Polifemo Radio photocells, at 1 m, 6 m and 11 m from the take off board and a Stalker ATS II radar. The data from 60 quantitative variables was obtained from each jump, referring to distance, time, speed and angle, during the phases of the approach run, takeoff, hop, step, jump and landing.

### RESULTS

For the set of samples, the linear discriminant analysis shows significant relations between the official jump distance (dependent variable) and the velocity at which athletes enter the take off board ( $p < 0.000$ ), the length of the step ( $p < 0.01$ ) and the ratio of the step with respect to the total distance of the jump ( $p < 0.01$ ). Based on the most associated variables, a linear regression model was constructed for the set of participants. However, when analysing each championship separately, different variables were found that explain the official jump distance according to each age group, also obtaining different linear regression models per age group.

### DISCUSSION

The variables that offer the best explanation of triple jump sports performance in a competition vary according to the sports training process of the jumpers, in other words, according to their age group. This could be used as a reference to establish the structure and distribution of physical and technical training content by age. Nevertheless, although two championships with the same determining variables were not found, there are two highly repeated characteristics: variables mainly referring to velocity appear and the most repeated one is the step ratio (%) with respect to the total jump distance. Although the step is the shortest of the three jumps, a higher ratio is correlated with best results ( $p = 0.004$ ).

## EFFECTS OF WEIGHTED VEST ON KINEMATICS AND KINETICS DURING VERTICAL JUMP IN SOCCER PLAYERS

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### INTRODUCTION

Training with weighted vests is a common resisted method to improve Jump performance in different sports such as soccer (4). However, little is known regarding the optimal load that must be used and also about the acute effects produced by the load increase in kinetics and kinematics variables (2). The aim of this study was to explain the acute effects using weighted vests with different loads on variables of force, velocity, power and RFD of CMJ and Abalakov jump in soccer players.

### METHODS

Eleven semi-professional male soccer players from 2<sup>nd</sup> B and 3<sup>rd</sup> division voluntarily participated in this study. Means and standard deviations of the characteristics of the participants were: age  $23.1 \pm 2.0$  years, height  $1.77 \pm 4.0$  m, body mass  $71.8 \pm 3.1$  kg. Subjects performed prior familiarization of Abalakov and CMJ jump. Measurements were performed with VICON system synchronized to KISTLER platform. 16 jumps were analyzed: 4 under unloaded conditions (2 CMJ and 2 Abalakovs) and 12 with increasing loads (5, 10 and 15% of body mass -Bm-). All loaded jumps were counterbalanced in order to minimize the effects of fatigue.

### RESULTS

Significant differences were found in both CMJ and Abalakov, between 0% and 5, 10 and 15% of Bm in vertical

jump height, take off velocity and relative peak power ( $p \leq 0.05$ ). Also significant differences were found between two kind of jumps (CMJ and Abalakov), in vertical jump height ( $0.50 \pm 0.04$  vs  $0.61 \pm 0.06$  m), relative peak power ( $6.22 \pm 0.61$  vs  $7.28 \pm 0.64$  W/kg) and concentric RFD ( $48692 \pm 7700$  vs  $53759 \pm 7899$  N/s) for unloaded conditions ( $p \leq 0.001$ ).

### DISCUSSION

Results from vertical jump height, take off velocity and relative peak power are according to the results obtained by Bosco et al., (1). In addition, Abalakov produces higher power levels, concentric RFD and jump height than CMJ. This is similar to results reported by Harman et al., (3). In conclusion, peak take off velocity and peak vertical power output with weighted vest in jumps is given when players jumping without any external load.

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## VALIDITY AND RELIABILITY OF AN IPHONE APP TO MEASURE VERTICAL JUMP HEIGHT

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### INTRODUCTION

Vertical jump performance is a key variable for several sports, and its measurement is widely used to evaluate lower limb power [1]. It has been demonstrated that a 240 frames per second (fps) high-speed camera can measure the flight time of vertical jumps in a valid, reliable way [2]. With the release of the iPhone 5s, which includes a 120fps high-speed camera, we wanted to know if such a device could measure the flight time of vertical jumps accurately.

### METHODS

Twenty recreationally active male sport science students (age = 22.1 ± 3.6 yrs.) performed 5 countermovement jumps, each one on a force platform working at 1.000Hz (Kistler 9287BA, Kistler Instruments Ltd., UK) while being recorded with an iPhone 5s at 120 fps. The flight times of the jumps on each video were calculated using an iPhone app that we developed for this study. Those flight times were compared with the flight times calculated from the force platform data. To analyze the validity and reliability of the iPhone 5s to measure the flight times in comparison with the force platform, we used the Pearson correlation coefficient and the intra-class correlation coefficient (two-way random effects, consistency). The level of significance was set at 0.05. All calculations were performed using IBM® SPSS® Statistics 22 (IBM Co., USA).

### RESULTS

The Pearson's correlation coefficient shows a nearly perfect association between the flight times values of the iPhone 5s and the force platform ( $r=0.995$ ,  $p<0.001$ ). The intra-class correlation coefficient shows an almost perfect agreement between both the iPhone 5s and force platform flight times (ICC=0.998, CI=0.996-0.998,  $p<0.001$ ). The mean difference between the iPhone 5s and the force platform flight times was 8.9 ± 4.2 milliseconds.

### CONCLUSIONS

The iPhone 5s using the app developed for this study can measure the flight times of vertical jumps in a valid, reliable, accurate, and economic way. These findings could help for coaches and trainers who wish to monitor the vertical jump ability of their athletes.

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## EFFECTS OF A 32-WEEK MULTICOMPONENT TRAINING ON BODY COMPOSITION, STRENGTH AND BALANCE IN OLDER ADULTS

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### INTRODUCTION

With the increasing of the population's lifespan and the knowledge of the importance of physical activity in later years, it is important to identify effective programs for older adults. Therefore, the purpose of the present study was to evaluate how age affects the responses on body composition, strength and dynamic balance to a 32-week multicomponent training (MT) in older adults.

### METHODS

126 subjects were stratified in two age groups, the young-old group (YO, 60 – 70 years old) and the old group (O, >71 years old) and were randomly assigned to an exercise (EG) and a control group (CG). The EG completed aMT (3 sessions of 50 minutes per week). Body composition, isokinetic lower limb strength, and agility /dynamic balance were assessed at baseline and after 32 weeks. Three-way ANOVA with repeated measures was used.

### RESULTS

No group differences were observed in baseline values, with the exception of the 8 foot Up and Go(UG) and trunk fat mass. After the 32 weeks, the YOEG decreased appendicular ( $11.84 \pm 2.87$  to  $11.42 \pm 2.75$  kg), total fat mass ( $25.85 \pm 6.50$  to  $25.05 \pm 6.41$  kg), improved total free-fat mass ( $42.25 \pm 8.82$  to  $42.61 \pm 8.89$  kg) and right knee extension peak torque ( $49.27\% \pm 19.51$  to  $54.11\% \pm 18.82$ ). Both YOEG and OEG showed a significant improvement in UG test score, and increased appendicular lean mass and

knee flexion peak torque. The OCG increased the trunk fat mass ( $9.91 \pm 3.88$  to  $10.52 \pm 3.52$  kg) and decreased total BMC ( $19.21 \pm 4.83$  to  $18.73 \pm 4.84$  kg) and BMD ( $1.03 \pm 0.14$  to  $1.01 \pm 0.14$  g cm<sup>-2</sup>) after 32 weeks. No significant changes were observed in YOEG.

### DISCUSSION

This study showed that 32 weeks of MT can produce significant changes in dynamic balance and in body composition- and strength-related variables and the rate of response was influenced by age, as the YOEG showed higher and better adaptations compared to the OEG. Physical activity is thought to decrease the skeletal muscle fat infiltration and muscle strength reduction that occurs with aging, consequently improving muscle quality (1), which corroborates the present results. Regarding bone mass, these findings are in accordance with previous data, which documented that age is an important predictor of BMD in older adults (2). Similar positive changes in dynamic balance have been shown in several other studies(e.g. 3).

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## DETRAINING EFFECTS AFTER 8 WEEKS OF TRAINING CESSATION PERIOD IN A TRAINED GROUP OF ELDERLY

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### INTRODUCTION

Exercise training for subjects over 65 should be applied to improve quality of life. However, physiological adaptations are transitory and disappear after training reduction or cessation (1). Beside detraining exerts well known effects in young athletes, while limited information is available for elderly individuals. The aim of this study was to investigate the effects of 8 weeks of detraining in elderly subjects (age > 65 yrs), after 12 weeks of exercise prescription at vigorous intensity.

### METHODS

17 healthy participants (69.3 ± 4.3 yrs) performed a randomized controlled trial on training program about 12 weeks at vigorous intensity (range 64-85% of Heart Rate Reserve) followed by 8 weeks of detraining. Before and after the training cessation period, subjects underwent an exercise test on a cycle Ergometer test until exhaustion to assess VO<sub>2</sub>max.

Heart Rate Recovery HRR, Waist-Hip ratio (WHR) and Body Mass Index (BMI) were also assessed. All the activities were monitored in real time by HR in Telemetry (Hosand) to maintain the %HRR and verified after training bout with an HRV test (MinicardioHosand). Paired t-test were used to compare the detraining effects on all variables before and after 8 detraining weeks.

### RESULTS

VO<sub>2</sub>max decreased by 6,65% during the training cessation period (24.2 ± 4.7 to 22.6 ± 4.5 ml/kg/min p=0.32). However, BMI decreased by 5,3% (26.5 ± 3.5 to 25.1 ± 3.9 kg/m<sup>2</sup> p = 0.24). Conversely HRR increased by 7% (62.1 ± 8.8 to 67.1 ± 9.2 bpm p=0.15) these decrement were not significant. WHR increased significantly by 9% (0.92 ± 0.06 to 1.01 ± 0.09 p<0.05).

### DISCUSSION

In the present investigation, after the training stoppage period following a vigorous training program, subjects were able to maintain a level of VO<sub>2</sub>max without a negative effect. Training exercise at vigorous intensity, instead of moderate intensity which is more commonly applied, was more positive also for BMI and HRR, otherwise The WHR were significantly different. Previous studies, employing moderate intensity (64% Heart Rate Reserve) showed higher tendencies to return back to the pre-training level during detraining. The Medical Doctors could consider also vigorous intensity exercise on the prescription (2) of physical exercise for elderly.

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## INFLUENCE OF INTER-REPETITION REST ON MAINTAINING MAXIMUM LOWER LIMB MUSCULAR POWER AGAINST DIFFERENT OVERLOADS

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### INTRODUCTION

Fatigue must be minimized when attempting to maximize power output (1).

One simple method to avoid fatigue is to perform low repetitions (reps) per set (2).

Another method that is gaining popularity in the last years is the Inter-Repetition Rest (IRR) training. IRR periods minimize muscle fatigue, enabling the performance of more reps per set before there is a significant power output loss (3).

Thus, the aim of this study is to determine the optimal range of reps to perform before it appears a significant power loss according to the pattern of movement (with or without rest between reps) and the load used (lower, optimal or higher than maximum power [ $P_{max}$ ]) in half squat.

### METHODS

16 active duty military men performed a progressive loading test to determine the load linked to  $P_{max}$  and 1-repetition maximum (1RM) in half squat exercise. The second day (48-72 h rest), they performed six maximal power output sets until a maximum of 20 reps with three loads: optimal load (OL), 15% lower (LL) and 15% higher (HL) respect to the load where  $P_{max}$  is attained. In a counterbalanced order, each subject performed one set without rest between repetitions (CR) and another set with 6 sec of rest between repetitions (IRR) with the 3 loads. Power output of each repetition was registered by a linear velocity transducer (T-Force, Murcia, Spain).

Only the first 12, 9 and 6 reps of LL, OL and HL, were analyzed.

### RESULTS

Subject's 1RM corresponded to  $151.3 \pm 19.5$  kg and  $P_{max}$  was set at  $67.0 \pm 5.6\%$  1RM. When  $P_{mean}$  was expressed as a percentage of the best of the two initial reps, significant declines in relative  $P_{mean}$  were observed in CR protocol at the repetition 7 ( $p=0.004$ ), 4 ( $p=0.002$ ) and 3 ( $p=0.012$ ) in LL, OL and HL, respectively. In contrast, for IRR significant declines were only observed in OL at rep 8 ( $p<0.001$ ). When considering  $P_{mean}$  losses of 15% regarding the best of the two initial reps, athletes increased the number of reps per set in a 318% (11 vs 35 reps for LL), 186% (7 vs 13 reps for OL) and 275% (4 vs 11 reps for HL) in IRR.

### DISCUSSION

Our results are similar to the ones found in previous studies, indicating that no more than 5 or 6 reps per set should be performed when considering  $P_{max}$  (1). However, when resting 6 sec between successive reps, the volume of sets may increase more than twice, maintaining the capacity to repeat maximal magnitudes power output. From our results, we conclude that IRR training may be a useful variable to consider when coaches design training programs for the development of muscular power. However, practitioners need to take into account that longer IRR periods may reduce post-exercise metabolic stress, compromising the gains in strength and muscle mass (3).

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## YO-YO IR2 TESTING OF ELITE SOCCER PLAYERS: HEART RATE RESPONSE AND DIFFERENCES BETWEEN COMPETITIVE LEVELS

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### INTRODUCTION

It's described that Scandinavian elite soccer players with better competitive level achieve a higher performance in the Yo-Yo Intermittent Recovery Test Level-2 (Yo-Yo IR2) (1). Further, Krstrup et al. 2006 showed that all these players were able to reach their maximum heart rate ( $HR_{max}$ ) during this test. This, coupled with the fact that the Yo-Yo IR2 is the most widely used test to measure the intermittent performance level of soccer players, makes particularly interesting to verify if that happens in other professional soccer leagues. The aim of this study was to examine the intermittent performance level of elite soccer players of different categories in a professional soccer Club (Spanish League) using the Yo-Yo IR2, and to check if this test is useful to discriminate the competitive level of the players. It was also an objective, to test if all players achieved their  $HR_{max}$  regardless of competitive level

### METHODS

For this study we recruited 102 soccer players from 6 age groups: Senior (Sr), Under 19 (U19), Under 18 (U18), Under 16 (U16), Under 15 (U15), Under 13 (U13). All of them performed a Yo-Yo IR2 (1) in which total distance was measured, and in which HR was recorded (Polar Team 2). We compared the  $HR_{max}$  reached during the test with the estimated  $HR_{max}$  (220-age) (2).

### RESULTS

Yo-Yo IR2 performance was, ordered from highest to lowest,  $1285.0 \pm 310.8$  m (U19),  $1031.4 \pm 167.7$  m (Sr),  $704.6 \pm 106.5$  m (U16),  $667.5 \pm 102.0$  m (U18),  $550.6 \pm 106.3$  m (U15) and  $542.2 \pm 84.8$  m (U13). U19 performance was significantly higher than Sr, and both were higher than the other age groups. U18 and U16 achieved a significantly higher performance than U15 and U13. The  $HR_{max}$  during the test was significantly lower than the estimated  $HR_{max}$  (220-age) in all age groups.

### DISCUSSION

Although described by Krstrup et al. (1), the Yo-Yo IR2 test does not clearly discriminate the different competitive levels of four Spanish elite soccer players. In addition, our results show that soccer players are unable to reach their estimated  $HR_{max}$  (220-age).

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## 30-15 INTERMITTENT FITNESS TEST VS. YO-YO IR2: RELATIONSHIP AND ABILITY TO DISCRIMINATE PERFORMANCE LEVELS

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### INTRODUCTION

The Yo-Yo Intermittent Recovery Test Level 2 (Yo-Yo IR2) is one of the most popular tests in soccer and examines the ability to perform repeated high-intensity exercise. Previous studies showed that Yo-Yo IR2 in elite athletes is higher than in non-elite athletes, and the test performance of 16-17-yr-old players was 30% lower than older elite players in the same club (1). The 30-15 Intermittent Fitness Test (30-15<sub>IFT</sub>) assesses high-intensity intermittent running capacity, and the final speed reached at the end of the test ( $V_{IFT}$ ) can be used for high-intensity interval training prescription (2). The aim of the present study was to examine the relationship and the ability for both tests to discriminate performance levels.

### METHODS

Sixty-nine soccer elite players and forty-three sub-elite players participate in the study. The protocols of Yo-Yo IR2 and 30-15<sub>IFT</sub> test have been detailed previously (1,2). We reported the distance covered during the Yo-Yo IR2 and the maximal speed reached at the 30-15<sub>IFT</sub>. Heart rate (HR) was continuously measured to determine  $HR_{max}$  at the end of the tests.

### RESULTS

Significantly differences in the  $HR_{max}$  reached at exhaustion between 30-15<sub>IFT</sub> and Yo-YoIR2 were found in elite and sub-elite U16 players, with higher values obtained during the 30-15<sub>IFT</sub>. There were no differences in the  $HR_{max}$  reached between teams in other age groups. The  $HR_{max}$  during both tests was significantly lower than the  $HR_{max}$  es-

timated (220-age). Elite U16 soccer players presented significantly higher  $V_{IFT}$  than sub-elite U16 players ( $20.4 \pm 0.6$  vs.  $18.9 \pm 1.3$  km.h<sup>-1</sup>, respectively), while there were no differences between teams in the Yo-Yo IR2 ( $627.7 \pm 135.2$  vs.  $674.7 \pm 164.8$  m, respectively). There were small correlations between  $V_{IFT}$  and Yo-Yo IR2 ( $r = 0.26$ ).

Elite U19 soccer players reflected significantly higher  $V_{IFT}$  and Yo-Yo IR2 than sub-elite U19 players ( $20.9 \pm 1.4$  vs.  $18.7 \pm 1.4$  km.h<sup>-1</sup> and  $1264.6 \pm 343.9$  vs.  $522.2 \pm 80.3$  m, respectively). There were very-large correlations between  $V_{IFT}$  and Yo-Yo IR2 (m) ( $r = 0.84$ ). Also, Elite senior soccer players showed significantly higher  $V_{IFT}$  and Yo-Yo IR2 than sub-elite senior players ( $21.1 \pm 0.8$  vs.  $19.6 \pm 1.1$  km.h<sup>-1</sup> and  $1084.0 \pm 150.2$  vs.  $522.2 \pm 106.7$  m, respectively). There were very-large correlations between  $V_{IFT}$  and Yo-Yo IR2 (m) ( $r = 0.77$ ).

### DISCUSSION

In Senior and U19 both tests were able to discriminate elite and sub-elite soccer players. In U16 players, only 30-15<sub>IFT</sub> reflected differences between performance levels showing higher  $HR_{max}$  than Yo-Yo IR2, maybe due to the neuromuscular load caused at this age by executing continuous COD at high speed.

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## THE EFFECT OF POST EXERCISE COLD WATER IMMERSION ON ACCLIMATION TO EXERCISE IN THE HEAT

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### INTRODUCTION

Previous research has shown that heat acclimation (HA) protocols conducted prior to arrival in a hot environment can improve exercise performance via physiological adaptations that improve heat tolerance. These beneficial adaptations include a lower rest and exercising core temperature ( $T_c$ ) and heart rate (HR), an expanded plasma volume (PV), and an increase in sweat rate (SR). To produce a more rapid acclimation to the heat, the inclusion of exercise is a necessary component. However, if cold water immersion is used to assist in recovery from this exercise, it would seem counterproductive to HA given that each heat exposure may be followed by cold exposure. Therefore, the purpose of this study was to investigate the effect of CWI, used as a post-exercise recovery intervention, on the process by which humans adapt to HA.

### METHODS

Eleven male subjects were randomly allocated to one of two groups: 1) cold water immersion (COLD;  $n = 6$ ), where each HA session was followed by a CWI recovery (20 min;  $14.4 \pm 1.4^\circ\text{C}$ ), or 2) control (CON;  $n = 5$ ), where each HA session was followed by a passive recovery in air ( $20.5 \pm 1^\circ\text{C}$ ). All participants completed a  $\dot{V}O_{2\text{max}}$  test, and a cycling performance test to exhaustion in the heat ( $34.8 \pm 0.9^\circ\text{C}$  temperature,  $40.7 \pm 8.6\%$  humidity), immediately prior to and following a 6-day HA protocol that comprised 75 minutes of heat exposure per day and included 45 min cycling at  $45\% \dot{V}O_{2\text{max}}$ . Measurements were taken for  $T_c$ , HR,  $\Delta\text{PV}$ , and  $\Delta\text{SR}$  throughout each testing and HA session.

### RESULTS

When expressed relative to baseline, HA was evident in both groups via lower mean exercising HR ( $126 \pm 0.6$  versus  $141 \pm 3.6$  beats.min<sup>-1</sup> for CON and COLD, respectively;  $P < 0.0001$ ), an increase in SR during exercise ( $80.2 \pm 0.4\%$  versus  $39.4 \pm 0.1\%$  for CON and COLD, respectively;  $P < 0.0001$ ) and the expansion of PV ( $17.8 \pm 11\%$  versus  $12.9 \pm 6\%$ , for CON and COLD, respectively;  $P < 0.05$ ). However, following the 6-day HA period, exercise performance in the heat tended to be increased in CON only (42%;  $P = 0.06$ ), in combination with a reduction in resting  $T_c$  ( $0.3^\circ\text{C}$ ;  $P < 0.05$ ).

### DISCUSSION

CWI as a method for recovery from training and competition is widely used by elite and sub-elite/recreational athletes to assist preparation for subsequent exercise. Although not unequivocal, the results of the present study suggest that CWI impacts on the physiological processes that lead to HA. Therefore, CWI should be used with caution during recovery from exercise undertaken whereby HA is a significant goal. Under such conditions, the mechanism underlying the attenuated increase in performance remains speculative. Therefore, future research should aim to clarify this response and shed more light on factors that may contribute to limiting the HA process before any clear recommendations can be made regarding the combined use of cold water immersion during a period of HA.

## EFFECTS OF COMPRESSIVE GARMENTS ON THE RECOVERY FROM HIGH INTENSITY PLYOMETRICS

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### INTRODUCTION

Compressive garments were originally used to treat deep thrombosis (1) and venous insufficiency (2,3). Subsequently, several authors have focused on the effect of compression in sport clothing, valuing its effect on resistance, strength and power, motor control, as well as different parameters, psychological, physiological and biomechanical; both during and post-efforts.

The objective of the study was to assess the effect of compressive garments in the processes of recovery of a high-intensity plyometric training.

### METHODS

40 healthy students were reallocated in four groups: Control (no garments), M\_rend (garments during training), M\_recup (garments during recovery) and M\_rend & recup (garments both in training and in recovery). We value the muscle fatigue during the 72 hours after this effort by using three types of test, counter movement jump (CMJ), squat jump (SJ) and repeated jumps (RJ).

### RESULTS

Found a minor loss of power in M\_rend & recup RJ with respect to group control in 1h, 24h, 48h and 72h after training ( $p < 0.05$ ). There is a trend to a higher power in CMJ of M\_Recup with respect to the control at 24 h ( $p = 0.058$ ).

### DISCUSSION

If the use of compressive garments improves more jump power within hours to a maximum effort, it might have benefits applied to sports training, optimizing the processes of recovery.

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## MONITORING MECHANICAL PARAMETERS DURING SMALL SIDED GAMES

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### INTRODUCTION

Soccer is a complex sport requiring the repetition of many different activities such as jogging, sprinting and jumping (1). It is essential to know how manage variables such as intensity, rest time or number of players in order to organize the well known "Small Sided Games" (SSG). Besides, the ability to sprint is a key parameter (2) and is the most frequent action in goal situations. In the review, we haven't found any research which relates specific SSG with simple mechanical parameters associated to fatigue neither the influence of repetition of this SSG sequences. Thus, the purpose of this study were: Firstly, to know the fatigue level produced by a SSG and investigate relationships between mechanical parameters related to jump and maximal sprint running before and after this specific situations.

### METHODS

Sixteen trained soccer players performed a maximal sprint of 30-m before the specific SSG. Instantaneous running velocity ( $v$  in  $m \cdot s^{-1}$ ) over time and distance was recorded with a radar Stalker ATS System<sup>TM</sup>. As well, a counter movement jump (CMJ) and a standing long jump (SLJ) were performed before the SSG.

The SSG was composed by 4 repetitions of: a straight sprint over 20-m (without ball), a change of direction and 20-m of 2-on-1 situation finishing with a shot. Immediately after the SSG, players performed a 30-m maximal sprint, CMJ and SLJ in order to check the decrease in performance.

### RESULTS

CMJ height and SLJ performance loss pre-post SSG were highly significant and were strongly correlated ( $r = 0.87$ ;  $p < 0.001$ ). The speed losses produced by the specific SSG presented a high relation with CMJ and SLJ exercises ( $r = 0.78 - 0.89$ ;  $p < 0.001$ ). Besides, top speed and the moment which is achieved in the maximal sprint running significantly decreased ( $p < 0.001$ ).

### DISCUSSION

High correlations found between mechanical responses (speed, CMJ height and SLJ performance losses) and the marked alterations observed in this study during a specific SSG, could be useful as indicators of fatigue. This could highlight the utility and validity of using CMJ and SLJ to monitor training load in different specific workouts, as has been proposed by Jiménez-Reyes et al (3). This data provides trainers a simple tool to monitor players fatigue and individual load which would then be used to design optimal training routines to improve players' training session.

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## EFFECTS OF SMALL-SIDED GAME TRAINING ON VERTICAL JUMP IN FOOTBALL

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### INTRODUCTION

A significant relationship has been observed between team averages for vertical jump performance and team success in football (1). The small-sided games (SSG) is a training method that include the ball in the physical fitness exercise played in reduced pitch areas (2). Most of the studies have included the SSG training program combined with normal football training, and it has been effective to improve physical fitness in football players during the pre-season (3, 4). However, no studies have analyzed the effect of SSG training on vertical jump performance at the end of the season without combined with any other normal football training.

### METHODS

Twenty two male participated in this study, 11 football players as the experimental group (20.4 ± 2.1 years; 71.8 ± 4.9 kg; 178.5 ± 5.4 cm, mean ± SEM, and eleven physical education students as the control group (21.5 ± 1.2 years; 75.9 ± 5.9 kg; 177.3 ± 5.8 cm). The experimental group trained during nine weeks, two sessions per week, with SSG training. The vertical jump was measured using a force platform (Kistler, Winterthur, Switzerland). The subjects performed 3 maximal squat jump (SJ) before and after the training program. During the jumps, the subjects were asked to keep their hands on the hips and to minimize horizontal and lateral displacement. The height jumped reached was determined in the best of the three trials for SJ, the best of them was used to represent the result in the vertical jump performance. Significant level were established at p<0.05.

### RESULTS

There were no significant different between groups in vertical jump performance after SSG training. The squat jump height (m) before and after for the experimental group were (0,62±0,08, 0,64±0,12, respectively) and for the control group (0,61±0,11, 0,62±0.06 respectively).

### DISCUSSION

Nine weeks of small-sided games at the end of the season did no improve the vertical performance in football players. Further studies could improve our understanding on how to best design of SSG in order to improve the vertical jump performance.

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## COMPARISON OF THE EXTERNAL LOAD IN 4-4-2 AND 4-3-3 TACTICAL SYSTEMS IN HIGH LEVEL SOCCER PLAYERS MEASURED WITH GPS DEVICES

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### INTRODUCTION

Each tactical system organizes players with specific roles. Therefore, the aim of the study was to determine if the external load is different in two tactical systems (TS) used during the preseason matches in elite soccer team, measured with GPS devices.

### METHODS

21 male players (20.9±1.7 years; 1.80±0.05 m; 73.1±5.3 kg) from the Athletic Club of Bilbao belonging to the 2nd division B participated in this study. Written informed consent was received from all players. The Ethics Committee of the UPV/EHU approved this study. External load were measured using a GPS system. During the pre-season 9 matches were evaluated (season 2012-13). Two tactical systems were analyzed: 4-4-2 system vs. 4-3-3 system. Moreover, data was analyzed in the five positions<sup>1</sup>. Different TS were used in each period of the matches. In each period the following variables were measured: total distance covered, average and maximum speed and intensity of the game: distance covered at 14-21 km/h (moderate-speed running); 21-24 km/h (high-speed running); >24 km/h (sprinting), as well as, the running velocity at high intensity (sum of the last three)<sup>2</sup>. Means, standard deviations were calculated. U-Mann Whitney was performed using SPSS (v20). The level of significance was set at  $p < 0.05$ .

### RESULTS

According to the TS, the running distance at high intensity in the 4-4-2 system was significantly higher ( $p=0.044$ ) than in the 4-3-3 (1046.19±247.35 vs. 960.64±247.92 m, respectively). Regarding the playing positions, the distance, high intensity and moderate-speed running covered and the average speed by forwards in the 4-4-2 system were significantly higher ( $p<0.005$ ) than in the 4-3-3 system (5070.42±247.07 vs. 4732.2±266.8 m; 1199.78±83.02 vs. 956.94±107.32 m; 915.55±73.14 vs. 725.69±107.94 m and 6.48±0.29 vs. 6.0±0.30 km/h, respectively).

### DISCUSSION

Both TS are categorized as systems of possession, but the obtained results show that the 4-4-2 system requires greater intensity. Therefore, the choice of the system could affect player's performance, which may affect the ability of task resolution due to fatigue. Furthermore, it seems that TS that keep the playing positions together require a lower intensity to perform the tactical roles. In addition, despite the differences in the positioning of the players in both TS, no differences were found in the midfield, wing-midfield and defense players. With these data, the coach may choose the type of TS according to the profile and physical fitness of the players.

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## BASKETBALL PERFORMANCE INDICATORS DURING THE ACB REGULAR SEASON FROM 2003 TO 2013

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### INTRODUCTION

In basketball, the use of performance analysis is an essential tool to obtain information about the opponents and/or your own players (1). Besides, the game-related statistics are very useful for basketball researchers in order to improve the understanding of this game (1,2). The main goal of the present study was to identify basketball game performance indicators which best explain the total number of victories during the regular season of the Spanish Basketball League (ACB). A second purpose was to determine game related indicators that differ among basketball teams qualified for the playoffs, teams non-qualified for the playoffs and teams that lost their ACB category.

### METHODS

The study sample consisted of all male basketball teams that participated in the ACB regular season from 2003-2013. Game-related statistics for each team during the whole year were obtained from the ACB website. Pearson's correlation coefficients were used to assess the association between game-related statistics and the number of victories. A multiple regression analysis was also performed to assess the variance in the number of victories explained by the game-related statistics. One-way analyses of variance was used to determine the differences among teams qualified for the playoffs, teams non-qualified for the playoffs and the teams that lost their ACB category.

### RESULTS

The percentage of successful 2 points field-goals ( $r = 0.66$ ) and the total number of assists ( $r = 0.59$ ) were the

variables that better correlated to the number of victories during the regular season. The regression analysis that explained the highest variance of the number of victories during the regular season ( $r^2 = 0.76$ ) included precision indicators (percentage of successful free throws and 2 and 3-point field-goals, 26% of variance explained), the total number of rebounds (defensive and offensive, 23%), the number of steals (9%), turnovers (7%), assists (6%) and the number of received blocks (6%).

The basketball teams that qualified for the playoffs obtained a higher percentage of successful 2 points field-goals, a greater number of assists and a lower number of received blocks during the regular season in comparison to the remaining teams ( $p < 0.05$ ). The last two teams qualified to the end of the regular season obtained lower percentages of successful throws (free throws, 2 and 3-point field-goals) and a lower number of assists than the other teams ( $p < 0.05$ ).

### DISCUSSION

The percentage of successes in all kind of throws and the total number of assists were game indicators most related to the number of victories suggesting that precision during field throws and the number of assists are the best predictors of elite basketball performance. This information may help basketball coaches to design specific training programs to improve the variables most related to the victory.

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## STRENGTH OR TECHNIQUE: WHAT SHOULD BE TRAINED TO INCREASE SWIMMING SPEED?

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### INTRODUCTION

Swimming speed is both dependent on strength and technique. Indeed, the balance between these two major factors may explain the success or failure in competitive events. However, competitive events vary enormously in terms of distance, and therefore time and intensity. Thus, an optimal level of strength is essential for successful performance in swimming (1), varying according to the distance to be swam (2). But how can swimming coaches track the balance between these two factors? And how can be identified if the swimmer must focus in one of them, in detriment of the other?

### METHODS

Twelve male and eleven female swimmers, with a minimum of 2-years' experience in resistance training, took part in a correlational explanatory design. Participants performed 3 maximal front crawl bouts tethered to the starting block (one bout with no constraints, one using only arms and one using only legs). A load-cell was used to assess instantaneous force-time curves. Mean values were estimated for each bout and correlated with swimming 100-m freestyle personal best.

### RESULTS

All participants, except two female swimmers, obtained lower mean forces swimming with no constraints than the sum of mean forces with constraints. In male swimmers sum of forces with only arms and only legs presented higher correlation with swimming performance ( $r=-0.703$ ;  $p=0.011$ ) than forces with no constraints ( $r=-0.525$ ;  $p=0.080$ ). In

female swimmers forces measured with no constraints presented a higher correlation with swimming performance ( $r=-0.780$ ;  $p=0.005$ ).

### DISCUSSION

Whereas the ability to use the muscle force output effectively in water is more important than the levels of strength (1), the relationship between exerted forces in water with swimming speed may provide an appropriate tool for specific evaluation. Moreover, the measurement of the forces exerted with arms and legs separately can provide a diagnostic tool for evaluation of strength deficits. Theoretically, it would be expected that the combination of the upper and lower limbs in a synchronized manner could generate a small amount of additional force exerted. Thus, the sum of the forces exerted by the arms and legs would be lower than those performed with the full body, which did not occur. For male swimmers the sum of the forces of the arms and legs showed a higher correlation with performance, suggesting that this group should give greater emphasis to technical training in order to be able to increase their ability to effectively use the muscle force output in the water. In contrast, female swimmers seem to have a greater margin of progression in strength training.

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## HIGH INTENSITY INTERVAL TRAINING IN PATIENTS WITH TYPE 2 DIABETES: DIABETES EM MOVIMENTO® TRIAL

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### INTRODUCTION

High intensity interval training (HIIT) has been recently recognized to improve health outcomes in non-athletes population and its generating a new interest in the reduction of cardiometabolic risk factors.<sup>1</sup> This study aimed to analyze the acute effects of a single bout of HIIT in blood glucose levels in patients with type 2 diabetes.

### METHODS

Fifteen individuals with type 2 diabetes (diagnosed at  $5.33 \pm 2.31$  years; eight women and seven men; age  $60.25 \pm 3.14$  years; glycated hemoglobin  $7.03 \pm 0.33$  %, treated with oral hypoglycemic agents) participated in a randomized controlled crossover study. Study sample underwent a single bout of HIIT and a control session of seated rest during standardized breakfast postprandial state, with one week apart and in random order. HIIT was conducted in a treadmill and consisted in a 5-min walking warm-up followed by 5 series of 3-min brisk walking at 70% of heart rate reserve (HRR), interspersed with 3-min at 30% HRR, followed by a 5-min walking cool-down, totaling a 40-min exercise session. Capillary blood glucose was measured before sessions, immediately after sessions, after 50-min laboratory recovery, before lunch, before mid-afternoon snack, before dinner, before bedtime and in next morning fasting state.

### RESULTS

Two-way ANOVA (condition\*time) identified a significant effect of condition\*time interaction on glycemia levels ( $p < 0.001$ ). After exercise start, blood glucose levels were always lower compared to control, with significant differ-

ences at the end of exercise ( $81.33 \pm 18.00$  vs.  $124.17 \pm 29.94$  mg/dl,  $p < 0.001$ ), at the end of the 50-min laboratory recovery ( $85.50 \pm 11.00$  vs.  $97.75 \pm 25.06$  mg/dl,  $p = 0.037$ ) and before dinner ( $108.17 \pm 14.08$  vs.  $119.00 \pm 19.48$  mg/dl,  $p = 0.022$ ).

### DISCUSSION

Acute control of blood glucose levels is crucial to reduce the risk of micro and macrovascular complications of diabetes. HIIT seems to have a positive effect in acute glycemic control in patients with type 2 diabetes, either in laboratory conditions either in free living conditions. *\_ENREF\_2\_ENREF\_1\_ENREF\_2* This type of exercise protocol can be safely applied in community-based exercise programs<sup>2</sup> designed for diabetic population if special attention is given to the prevention of exercise-related injuries and adverse events.<sup>3</sup>

### FINANCIAL SUPPORT

*Diabetes em Movimento®* Trial was funded by Portuguese Foundation for Science and Technology (SFRH/BD/47733/2008) and is registered in *Current Controlled Trials* (ISRCTN09240628).

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## HIGH INTENSITY RESISTANCE TRAINING ADAPTATION ON STRENGTH, BODY COMPOSITION AND AEROBIC CAPACITY IN SEDENTARY INDIVIDUALS

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### INTRODUCTION

In the last years Resistance Training (RT) has been incorporated in the common Guide Lines as an important component of physical exercise (ACSM 2011). Numerous studies have demonstrated that RT could improve muscular strength and also aerobic capacity (Petersen 1989; Keller 2001); but a varied range of different exercise executions composes RT, and the combination of these variables could influence in a different way the adaptive response to training (Paoli 2012). One of the main variable of RT is intensity (load given/duration of exercise). High Intensity Interval Resistance Training (HIRT) is a resistance training program that consist in performing few repetition with high load with a very short rest between sets. The aim of this study was to compare the effects of HIRT and Traditional low-intensity Training (TT) on muscular strength, body composition and aerobic capacity.

### METHODS

20 healthy young volunteers (age: 22.2±2.0 years; BMI: 23.6±1.6) trained for 2 month, 3 times a week. Training protocol consisted of one exercise for major muscle groups. DEXA analysis, maximal incremental exercise test on a cycle ergometer, and 1 repetition maximum (1RM) were investigated before and after 8 weeks of training.

### RESULTS

Both groups increased their strength on all exercise, whereas the HIRT group improved more than TT (36% vs

24%). Exercise duration on the cycle ergometer improved for both groups without any group-by-training interaction. Only in TT group the work rate increased significantly (+5.3%). VO<sub>2</sub> increased in both groups with no significant differences between training; no significant alterations were found for other aerobic variables measured. Body composition analysis shown a significant greater improvement of body fat (-1.8%) in TT whilst a significant greater increase in lean mass (+3%) in HIRT.

### DISCUSSION

Both training protocols produced a significant improvement in strength and aerobic capacity during a 8-week training period; while the HIRT protocol produced better gains in muscular hypertrophy, TT protocol seems to have better improvement on body composition and short-term endurance. RT intensity seems not to influence aerobic capacity after 8 week of training but it could be an important factor influencing muscular strength and body composition.

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## LOWER LIMBS ISOMETRIC STRENGTH AND BONE FRACTURE INDEXES IN ADOLESCENTS WITH DOWN SYNDROME

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### INTRODUCTION

Measurement of leg extension strength is a non-invasive test that might provide interesting information regarding muscle and/or bone mass; factors closely associated with present and future health. Adolescents with Down syndrome (DS) are characterized by lower levels of bone mass than their non-DS peers, and higher fracture risk (1). Whether these two factors are also related in a DS population would be interesting to know in order to screen them before an invasive X-ray assessment is carried out. Therefore, the aim of the present study was to describe, if it does exist, a relationship between muscular strength and bone strength indexes at the lower limbs in adolescents with DS.

### METHODS

Twenty-four adolescents with DS (8 girls) participated in the study. Peripheral quantitative computed tomography (pQCT) measurements were taken at 38% of the tibia length; stress strain index (SSI) and resistance to fracture load (FRC\_LD) in X and Y axis, bone strength index (BSI) and polar strength strain index (SSIPol), were calculated from this measurement. Maximal isometric strength (MIS, kg) of the leg muscles was measured using a strain gauge attached to the wall with a chain mounted and an adapted anchorage attached to the distal third of

the leg. Pearson's bivariate correlations were applied between MIS and the different bone parameters in the whole sample, and also splitting by gender.

### RESULTS

Analysing as a whole group, all bone-related variables had a medium to strong correlation with MIS (from  $r=0.54$  to  $r=0.64$ ; all  $p<0.05$ ). Analysing by gender, no correlations were found for DS girls in any variable, while stronger correlations were found in the boys group between bone parameters and MIS (ranged from  $r=0.63$  to  $r=0.76$ ; all  $p<0.05$ ).

### CONCLUSION

The use of a MIS test in the lower limb of adolescents with DS, specially in males, might be a good screening to determinate the relative risk of fracture, and therefore the need to undertake a X-ray scan or another invasive imaging technique for determining this.

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## SPANISH JUNIOR SWIMMING TEAM: LEGS STRENGTH-POWER AND ITS RELATION WITH SWIMMING PERFORMANCE

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### INTRODUCTION

Swimming races are divided into different phases: start (ST), swim (SW), turn (TR) and finish (F) where the swimmer performs specific skills that must be independently evaluated (1). Several authors have studied the relationship between the swimming phases and the strength-power performance (2). The junior athletes have different maturity levels as well as different needs. In addition, their changes in performance may occur more quickly than in senior athletes, so they should be periodically evaluated to train accordingly. We aim to describe the swimming phases and the squat jump performance (SJ) as well as to study the relationship between them, in a group of international junior swimmers.

### METHODS

19 male swimmers (age:  $16.4 \pm 0.9$  years), from the Spanish national junior team, were tested along three consecutive days. On the second day, a "50m + turn" (15m) freestyle test was performed in order to get the main kinematic variables obtained in the standard competition analysis. Nine cameras (50Hz) set perpendicularly to swimmer's displacement recorded the trials. A specific Filemaker-Quicktime script was used for the temporal analysis. On day 1 and 3, the swimmers, randomly divided in two groups, performed a SJ protocol test. They performed one unloaded jump (0%) and four more with the 25%, 50%, 75% and 100% of their body weight. Peak velocity (V) was registered by a linear velocity transducer (T-Force, Spain). Height of the jumps (H) was estimated by Optogait System (Microgate, Italy).

### RESULTS

The times (s) obtained were: ST10m:  $4.07 \pm 0.21$ ; ST15m:  $6.86 \pm 0.30$ ; SW15-45m:  $17.76 \pm 0.57$ ; TR45-65m:  $11.63 \pm 0.42$ . H decreased due to the load increase. H0%:  $29.56 \pm 3.88$ ; H25%:  $21.25 \pm 3.09$ ; H50%:  $15.36 \pm 2.53$ ; H75%:  $11.84 \pm 1.94$ ; H100%:  $7.11 \pm 1.85$ . The same pattern was observed in the V, V0%:  $3 \pm 0.3$ ; V25%:  $2.58 \pm 0.16$ ; V50%:  $2.25 \pm 0.14$ ; V75%:  $1.99 \pm 0.13$ ; V100%:  $1.73 \pm 0.12$ . We found that ST10m and ST15m were significantly correlated ( $p \leq 0.05$ ) with H and V in the five sets of SJ. Correlations reached  $r = -0.743$  between ST10m and H25%. SW15-45m only showed correlation with V50% ( $p \leq 0.05$ ,  $r = -0.509$ ). No significant correlation was found for the turning times.

### DISCUSSION

The relation between the strongest and the fastest swimmers seems to be more evident in the starts' performance. Similar results have been recently observed (2). This study presents some reference values as well as significant relationships between conditional variables and swimming performance. These findings may help coaches in the performance assessment, the talent identification and/or the setting of new goals.

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## THREE-DIMENSIONAL ANALYSIS OF GRAB- AND TRACK-START IN THAILAND SWIM TEAM: A CASE STUDY

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### INTRODUCTION

The ability to perform different technical tasks is critical for swimming performance. Knowing that starting is a very important technical domain for swimming performance (Hay, 1986), we aimed to kinematically characterize and compare the grab- and track-start techniques performed by a Thai top swimmer using a three-dimensional analysis.

### METHOD

A 15-y-old female breaststroke swimmer from the Thailand National Team (54kg of body mass, 174cm of height, and 73.1s as best performance in 100m breaststroke long course- 86.40 % of World Record) volunteered to perform a grab- and a track-start as in competition conditions. Eight stationary Qqus high speed motion capture cameras (500 Hz and 1/120s of shutter speed) were repositioned to capture the movements of the swimmer (xz - sagittal plane, yz - frontal plane, xy - transverse plane). Qualisys QTM Software was used for all data assessments. The kinematical analysis focused on block leaving, flight and entry phases, evaluating a total of 16 parameters.

### RESULTS

Track-start technique showed a shorter total time from block to full body entry than grab-start technique (1.31 vs. 1.44s) due to the shorter time spent to leave the block (0.64 vs. 0.84s), similar flight time (0.37 vs. 0.37s)

and low time in water entry (0.30 vs. 0.23s). The angle of take-off in grab-start was smaller than in track-start technique (34.49 vs. 41.73°), with higher segment velocity than track-start in sagittal plane (xz) of the center of gravity at takeoff (3.99 vs. 3.33 m·s<sup>-1</sup>), head movement (4.25 vs. 3.27 m·s<sup>-1</sup>), hand movement (6.24 vs. 5.40 m·s<sup>-1</sup>) and transverse plane (xy) of knee movement (2.41 vs. 1.58 m·s<sup>-1</sup>), respectively. The lower angle of entry in the track-start in relation to the grab-start (19.90 vs. 30.30°) was partly related to the velocity of the center of gravity at the beginning of entry tends to be higher (3.82 vs. 3.46 m·s<sup>-1</sup>).

### DISCUSSION

Current data evidenced that track start technique was faster than grab-start probably due to the lower time period spent in the starting block. The main differences noticed between the two start techniques seems to be related to the angle of take-off and beginning of entry, as it is directly related to velocity of body segments of flight phase and flight time.

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## ACUTE EFFECT OF STRENGTH TRAINING WITH ECCENTRIC OVERLOAD ON KINETIC PARAMETERS ASSOCIATED DURING SIDECUTTING

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### INTRODUCTION

Strength training with eccentric overload is frequently used in team sports as a strategy for muscle injury prevention (1). In several studies it has been observed an acute proprioceptive impairment as a result of the use of these eccentric actions (2,3). In this sense, the main aim of this study was to analyze the acute effects of strength training with eccentric overload on different kinetic parameters associated with a change of direction task.

### METHODS

Twenty players under 19 belonging to a professional football team (age =  $17 \pm 1$  years, height =  $178.11 \pm 2.34$  cm, weight =  $71.76 \pm 4.56$  kg, BMI =  $19.12 \pm 2.45$  kg · m<sup>-2</sup>) were involved in the study. Subjects were randomized to one of three interventions separated between 72-96 h: a) standardized warm-up with cycle ergometer (CON), b) strength training with maximum power load (Pmax) and eccentric overload using a Yo-Yo leg curl machine (EXP-H) and c) strength training at Pmax and eccentric overload using a Yo-Yo squat machine (EXP-Q). A 20 m sprint test was performed after each intervention. Each trial finished with a change of direction at an angle of 45° (opposite to the support leg) on a force platform. Outcome measures analyzed were as follows: peak vertical force (GRVF), force moments in the medial-lateral (Mx) and antero-posterior (My) axes and support time (ST).

### RESULTS

A significant interaction for ST ( $p < 0.05$ ) was observed when EXP-H was compared to CON.

### DISCUSSION

Strength training with eccentric overload at Pmax performing squat and leg curl exercises does not cause a change in the kinetic parameters associated with a change in direction. According this response, training load used didn't elicit an acute proprioceptive impairment, as proposed by other authors (2,3). Moreover, a lower ST time following the EXP-H treatment was observed. There are numerous mechanisms potentially responsible for this response exhibited. The possibility exists that the EXP-H treatment was effective in eliciting a post activation potentiation (PAP) response, an increase in the contractile ability of muscle following a bout of previous contractions (4).

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## THE EFFECTS OF A CONCURRENT STRENGTH AND ENDURANCE TRAINING ON ENDURANCE AND MUSCLE STRENGTH IN SOCCER PLAYERS

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### INTRODUCTION

The optimal development of cardiovascular and neuromuscular characteristics of soccer players requires the combination of endurance and strength training programs. Previous studies have examined the effects of various concurrent endurance and strength training programs on endurance, muscle strength, peak torque, vertical jump ability, sprint performance, and flexibility in various athletes (Gorostiaga et al., 1999; 2004; Bishop et al., 1999; Paavolainen et al., 1999). A number of studies suggested that a concurrent training may interfere with strength (Kraemer et al., 1995) or endurance (Glowacki et al., 2004) improvement, whereas other studies do not support these inhibitions (Gorostiaga et al., 2004; Paavolainen et al., 1999) when a resistance and endurance performed simultaneously. The purpose of this study was to compare the effects of an 8-week endurance training and concurrent strength and endurance training program on endurance and neuromuscular performance in young soccer players.

### METHODS

Twenty-seven young soccer players, aged 17-19 years, were assigned to one of two groups: concurrent strength and endurance training (CT; n=14), and endurance training (ET; n=13). Both groups were evaluated in the 1-RM squat muscle strength, peak torque of knee extensors at 180°/sec, running velocity at the fixed blood lactate concentration of 4mmol/l (V-4mM), squat jump (SJ) and countermovement jump (CMJ) height, and 30m sprint time before and after the 8-wk training period. Both groups performed every week five soccer training sessions and a soccer match. Concurrent and endurance training programs were parts of the soccer training sessions. The ET performed interval training two times per week, Tuesday and Friday. The interval soccer training consisted of four 4-min at an exercise intensity between 90-95% of maximal heart rate for each player with 2-min passive rest was performed between exercise bouts. The CT group performed the strength and endurance training programs in two consecutive days. The strength training program consisted of half squat exercise and was intended to provide a stimulus for the muscles of the lower limbs. The first four weeks, CT performed 3 sets of 6-8 repetitions, whereas from the fifth week until the end of the resistance training participants performed 4

sets of 4-6 repetitions. Loads were increased when participants were able to perform more than the targeted number of repetitions with the current workload. After the half squat exercises, CT group performed 3 sets of 5 repetitions maximal vertical jumps, and 3 sets of 4 repetitions sprints (10-40m). The total duration of the strength training did not exhibit the 30 min.

### RESULTS

Both CT and ET groups increased significantly ( $p < 0.001$ ) the V-4mM after the training period, by 13% and 16%, respectively. CT improved significantly ( $p < 0.001$ ) the 1-RM squat strength (9%), peak torque of knee extensors (5%), SJ height (9%), CMJ height (8%), and 30m sprint time (2.7%), whereas no changes were observed in ET group.

### DISCUSSION

These data suggest that there is not an interfere phenomenon between the present strength and endurance training programs. Previous studies have used explosive or heavy strength training programs combined with endurance training, with various results (Gorostiaga et al., 1999; 2004; Paavolainen et al., 1999). Muscle strength is an important component for improving the physical and technical performance in soccer (Kalapotharakos et al., 2006). The enhancement of 1-RM muscle strength and peak torque of knee extensors at 180°/sec after the concurrent training is due to the strength training program. Force increments through a short term heavy resistance training are attributed primarily to neural mechanisms (control, coordination, motor activation), while morphological (hypertrophy) adaptations of neuromuscular function follow (Kalapotharakos et al., 2004).

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## A COMPARISON OF PHYSICAL CHARACTERISTICS AND ABILITIES BETWEEN SERBIAN PROFESSIONAL VOLLEYBALL PLAYERS AND YOUNG PLAYERS (AGE 16-18 YEARS OLD) AT AN INTERNATIONAL VOLLEYBALL CAMP

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### INTRODUCTION

The purpose of this study was to investigate physical characteristics of professional Serbian players and young players and compare these two groups. The evaluation of present practices through research conduction can be used to develop better training programs suited to the needs of the competitive player (1).

### METHODS

Fifty young players, (N = 50 males, between 16 to 18 years old) as group 1 (G1), and 16 professional volleyball players (N = 16 male, between 18 to 36 years old) as group 2 (G2) participated in this study. The test battery was designed to measure maximal muscular functional performance in this discipline. It consists of the following measurements: weight, height, standing reach for smash and block, flexibility, long jump, jump reach in smash, reach in block without arm swing, reach in block with arm swing, number of sit-up repetitions in 30 sec., agility (5m), 10m sprint. (2)

### RESULTS

Weight (G1=70.0 ± 9.7 kg; G2=88.6 ± 7.8 kg) BMI (G1=21.5 ± 2.2 kg/m<sup>2</sup>; G2=23.9 ± 1.0 kg/m<sup>2</sup>). Height (G1=180.1 ± 8.2 cm; G2=192.5 ± 6.9 cm) Standing reach in smash (G1=235.6 ± 11.2 cm; G2=252.9 ± 9.0 cm) Standing reach in block (G1=232.3 ± 10.9 cm; G2=248.3 ± 8.7 cm) Reach in smash (G1=289.6 ± 18.6 cm; G2=324.4 ± 6.6 cm) Reach in block without arm swing (G1=272.7 ± 15.2 cm; G2=302.1 ± 7.6 cm), and Reach in block with arm swing (G1=276.1 ± 15.1 cm; G2=304.7 ± 7.4 cm) Jump height

during smash (G1=53.8 ± 10.7 cm; G2=71.5 ± 8.1) Jump height during block with arm swing (G1=43.7 ± 7.6 cm; G2=56.4 ± 7.2 cm) Jump height during block without arm swing (G1=40.4 ± 7.7 cm; G2=53.9 ± 6.5 cm) Long jump (G1=213.1 ± 29.3 cm; G2=264.9 ± 22.2 cm) Flexibility (G1=-7.5 ± 9.2 cm; G2=-16.5 ± 13.9 cm) Abs - (G1=29.7 ± 4 reps; G2=36.7 ± 2.4 reps) Agility - (G1=11.8 ± 1.2 times; G2=14.0 ± 0.6 times) Speed - (G1=2.3 ± 0.2 sec; G2=1.8 ± 0.2 sec)

### DISCUSSION

The data analysis revealed no significant difference between young players and professional players in variables like weight, BMI, standing reach in smash, standing reach in block, reach in smash, reach in block without arm swing and with arm swing, jump height during smash, long jump, flexibility, repetitive abs power and agility. Only have been found significant differences about height measurements, jump height during block with and without arm swing and sprint on 10m. We think that differences come because of selected athletes (professionals) during their growing period, better block technique, specific longer and better physical preparation and age.

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## VELOCITY-BASED VS TRADITIONAL STRENGTH TRAINING IN PROFESSIONAL SOCCER PLAYERS

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### INTRODUCTION

Sprints, jumps and kicking are considered relevant factors for successful performance and widely related to strength (1). Traditionally, the training protocols used for increasing strength training consisted in a set of exercises in which athletes lifted heavy weights (nearly 1RM) with difficulties for considering the real effort of athletes. However, several authors have stressed the importance of movement velocity in the prescription and control of resistance training (2, 3), establishing for some exercises that by measuring movement velocity it is possible to determine the %1RM and real effort. Considering the aforementioned above strength programming training, the main purpose of this study was to investigate the effects of using a traditional strength training (TST) with a fixed intensity and a velocity-based strength training (VST) monitoring real intensity in professional Spanish soccer players

### METHODS

Eighty professional soccer players (four teams) took part in the study (24.4 ± 5.21 yr, body mass 73 ± 4.6 kg, height 177.4 ± 5.4 cm, body fat 9.3 ± 2.3%), who play in the Spanish first and second division leagues were distributed in a TST and VST groups, doing a personalized and individualized training (twice weekly; 6RM, and 1m · s<sup>-1</sup> movement velocity and 20cm in CMJ for TST and VST, respectively). Four teams were evaluated at the beginning of the competitive period, and at the end of the first half of the regular season. The following were evaluated: the strength of the lower extremities by CMJ, CMJ loaded until the jump

height was around 20 cm (CMJ<sub>20cm</sub>) and full squat until the execution speed was 1m · s<sup>-1</sup> (Sq<sub>1ms</sub>) and the sprint time 20 meters.

### RESULTS

CMJ and Sq<sub>1ms</sub> performances improved significantly for TST and VST groups, respectively (p < 0.05; p < 0.001) showing a surprisingly higher improvement in the VST (12%; p < 0.001; effect size (ES) of 1.24 in CMJ; 14%; p < 0.001; ES of 1.37 in Sq<sub>1ms</sub>) compared to the TST (4%; p < 0.05; ES of 0.49 in CMJ; 7%; p < 0.05; ES of 0.73 in Sq<sub>1ms</sub>). For CMJ<sub>20cm</sub> and 20-m sprint only the VST improved significantly (15%; p < 0.001; ES of 1.98 in CMJ<sub>20cm</sub>; 5%; p < 0.05; ES of 0.61 in 20-m sprint).

### DISCUSSION

These findings indicate that VST produces better physical performance effects than TST and a specific improvement in power output related patterns, suggesting that this methodology is more adequate for strength improvement for in-season training in professional soccer.

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## INCREMENT OF STRENGTH AND MUSCULAR POWER IN THE SCHOOL CONTEXT

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### INTRODUCTION

Studies related to strength trainability in young people continue to be limited, especially when it relates to school environments. But from a scientific point of view children and adolescents can increase their muscular strength beyond normal growth when they participate in an adequate training programme with intensity, volume and duration (Faigenbaum and Myer, 2010; Faigenbaum, 2011). The main aims of this study are to analyze: (i) if motor capacity strength and muscular power, in general, improve in the school context and (ii) if the implementation of a strength training programme has greater gains than in normal physical educational classes (PE).

### METHODS

The study involved two groups of 10<sup>th</sup> graders from Pereirade Melo secondary school, Porto. It consisted of 15 female participants who were allocated to two groups: a control group with 8 students and an experimental group with 7 students. The process implied the execution of the following tests to assess muscle strength and muscular power: 60" push-ups, 30" curl-ups, 2kg medicinal ball (MB) throws, static horizontal jumps, sextuple jumps and 50m runs. The strength training programme consisted of a set of exercises with short dumbbells: calf raises, lunges, half squats, bench press, butterfly, vertical row, abdominal and lower back (2 sets of 10-15 repetitions at ca. 60% 1RM). These exercises were carried out twice weekly and the training program lasted 6 weeks.

### RESULTS AND DISCUSSION

In the experimental group, the gains are statistically significant in push-ups, suspension, 2kg MB throw, sextuple

horizontal jumps (26,6%, 7,9% , 9,7%, 4,8% and 7,6% respectively) however the control group also had significant improvement in throwing the MB and sextuple jumps (3,5% and 5,5% respectively), which were evidenced in the non-parametric statistics in the Wilcoxon test. This may suggest that normal PE classes and maturation can induce enhancement in physical performance. Although the experimental group showed better changes in all the tests, only in the static horizontal jumps did it have sufficiently greater/robust gains which statistically differentiate it from the control group ( $p=0.032$ , Mann-Whitney test).

### CONCLUSION

This study demonstrated that physical education classes can induce improvement both in strength and muscular power in these female students. However, the efficacy of the strength training programme was not totally proven, because the time of application perhaps was limited. We can say that regular PE classes and maturation can induce enhancement in physical performance. In addition, organized physical education lessons, based on strength training plans, develop and achieve better evident gains. Therefore, both processes generate well-being and healthy habits in children and adolescents throughout life.

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## CAN AEROBIC POWER ( $\dot{V}O_{2\text{MAX}}$ ) BE ASSESSED BY BACKWARD EXTRAPOLATION IN SWIMMING?

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### INTRODUCTION

The maximum power at which the oxidative system can operate - aerobic power - is traditionally assessed by determining the maximal oxygen uptake ( $\dot{V}O_{2\text{max}}$ ). In swimming, although the gold standard technology for  $\dot{V}O_2$  assessment is reliable and reproducible (direct oximetry using bxb measurements, cf. Baldari et al. 2013), the ecology of competitive events seems to be impaired (Keskinen et al. 2003). To minimize this problem, an alternative methodology was proposed: the backward extrapolation of the oxygen consumption ( $\dot{V}O_2$ ) recovery curve (Lavoie et al. 1983). Our aim was to verify if the  $\dot{V}O_{2\text{max}}$  values obtained during a time to exhaustion at the velocity that elicits  $\dot{V}O_{2\text{max}}$  test (TLim- $\dot{V}O_{2\text{max}}$ ) could be assessed accurately using backward extrapolation.

### METHODS

Nine trained swimmers performed an intermittent incremental protocol for the  $\dot{V}O_{2\text{max}}$  assessment (Fernandes et al. 2003). 24h later, they performed a TLim- $\dot{V}O_{2\text{max}}$  in which their  $\dot{V}O_2$  kinetics was evaluated.  $\dot{V}O_2$  was directly measured using a K4b2 connected to the Aquatrainer, a low hydrodynamic resistance respiratory snorkel and valve system (both from Cosmed, Italy). A visual pacer controlled velocity and swimmers used continuous rhythmical breathing during the effort and in the recovery period. Expired gas concentrations were measured bxb and averaged every 5s. Backward extrapolation consisted in a linear regression curve between time (20s immediately after the 10s of dead space to simulate a simple recovery assessment) and  $\dot{V}O_2$  to predict the  $\dot{V}O_2$  at time zero. Paired Samples Test, correlation and agreement between  $\dot{V}O_{2\text{max}}$  values using direct oximetry and backward extrapolation during TLim- $\dot{V}O_{2\text{max}}$  were applied.

### RESULTS

$\dot{V}O_{2\text{max}}$  obtained with direct ventilatory data collection and using backward extrapolation were similar ( $57.11 \pm 8.38$  vs  $58.50 \pm 7.94$  ml·kg<sup>-1</sup>·min<sup>-1</sup>,  $p = 0.42$ ) and positively correlated ( $r = 0.82$ ,  $P < 0.01$ ). Moreover, Bland-Altman plot showed that  $\dot{V}O_{2\text{max}}$  can be accessed through backward extrapolation with a Bias of only  $-1.40$  ml·kg<sup>-1</sup>·min<sup>-1</sup> (-2.59%).

### DISCUSSION

It was observed that a simple 20s breath sample seems to be reliable in assessing  $\dot{V}O_{2\text{max}}$  values at aerobic power intensity. So, as  $\dot{V}O_{2\text{max}}$  is a relevant endurance performance index, when aiming to a more ecologic and coach friendly approach, its assessment using backward extrapolation seems to be an excellent alternative.

### FINANCIAL SUPPORT

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## MAXIMAL AEROBIC SPEED AND $VO_{2MAX}$ IN ROLLER SPEED SKATING

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### INTRODUCTION

Roller Speed Skating combines the movement pattern of ice speed skating and the pack-oriented competition modes from cycling (2). Few studies have been made about roller speed skating physiology (1,2); many of them registered the  $VO_2$  values, however, they did not investigate the relationship with the Maximal Aerobic Speed (MAS). The aim of the present study was to assess the  $VO_2$  and MAS values and their association in Roller Speed Skaters.

### METHODS

Twelve elite roller speed skaters (19.4±4.6 years) performed two progressive incremental tests (T1 and T2) in a 200m indoor track (skating at 15 km·h<sup>-1</sup>, step duration of 1 minute, and increments of 1 km·h<sup>-1</sup> up to exhaustion). T1 was performed with a portable metabolic gas analyzer, Jaeger Oxycon Mobile. T2 was performed with a heart rate monitor, Polar RS800. Heart rate (HR) and lactate samples (LS) were collected in T1 and T2.

### RESULTS

The results in test T1 were: 4167.9±456.5 mL·min<sup>-1</sup> of absolute  $VO_{2max}$ ; 60.2±7.6 mL·kg<sup>-1</sup>·min<sup>-1</sup> of relative  $VO_{2max}$ ; and 159.8±22.3 L·min<sup>-1</sup> of maximal ventilation. The MAS was 35.7±1.6 km·h<sup>-1</sup> in T1 and 36.7±1.6 km·h<sup>-1</sup> in T2. The maximal HR was 195.2±7.5 bpm in T1 and 196.3±9.2 bpm in T2. The maximal values of LS were 12.9±2.9 mmol·L<sup>-1</sup> in T1 and 13.9±1.6 mmol·L<sup>-1</sup> in T2. No correlation appeared between  $VO_{2max}$  and MAS in T1 ( $r=0.271$ ;

$p>0.394$ ). A large significant correlation between T1 and T2 was found in MAS ( $r=0.965$ ;  $p<0.001$ ) and in maximal HR ( $r=0.800$ ;  $p<0.002$ ). Despite, there were significant differences between T1 and T2 in MAS ( $p<0.001$ ), no differences appeared in maximal HR ( $p>0.508$ ) and in maximal LS ( $p>0.258$ ).

### DISCUSSION

The  $VO_{2max}$  obtained similar values as other elite level ice speed skaters (1) and elite level roller speed skaters (1,2). The MAS was the highest found in studies with roller speed skaters (2). Roller Speed Skating does not depend on physiological parameters only (3); the biomechanical pattern of the speed skaters determines the MAS too, since an absence of correlation between  $VO_{2max}$  and MAS was observed. MAS may be affected by the protocol, the conditions or the material employed in tests. Then, control of these variables should be made in order to use MAS for training prescription or talent acquisition in roller speed skating.

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## THE USE OF GRADUATED COMPRESSION STOCKINGS DURING THREE WEEKS DOES NOT INFLUENCE CARDIORRESPIRATORY PERFORMANCE

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### INTRODUCTION

The number of runners using Graduated Compression Stocking (GCS) is increasing for their potential cardiorespiratory improvements. However, recent studies have not found enough evidence to support this idea. The aim of this study was to examine the cardiorespiratory responses during running after three weeks of Graduated Compression Stockings use.

### METHODS

Twenty runners performed three running tests on different days: test 1) a 5-min maximal effort run on a 400-m track in order to determine the individual's maximal aerobic speed; tests 2) and 3) a fatigue running test of 30 min at 80% of their maximal aerobic speed with GCS or placebo stockings. Cardiorespiratory measurements were registered by a gas analyzer and a heart rate belt. Before the tests, runners trained with the assigned stocking (GCS or PLACEBO) during three weeks. The difference between the end and the start of the fatigue run was analyzed between conditions (GCS vs PLACEBO).

### RESULTS

No differences were found in any of the cardiorespiratory variables analysed (minute ventilation, heart rate, relative oxygen consumption, relative carbon dioxide production, ventilatory equivalents for oxygen and carbon dioxide, and oxygen pulse) between GCS and PLACEBO.

### DISCUSSION

Running economy is an important factor to predict middle- and long- distance running performance, and clothing may be an additional factor to change running economy (Bringard et al., 2006). Bringard et al. (2006) observed improvements in running economy with GCS while other studies did not find any difference (Ali et al., 2010). In the present study, no differences in running economy (difference between the end and the start of the test in  $VO_2/KG$ ) were found when using the GCS or the placebo garment. Discrepancies between results could relate to the training status of participants and not to the test intensity. Previous studies have suggested that the increase in venous return results in a reduction of heart rate. In the present study there were no differences in HR when using GCS or the placebo garments, which is also in accordance with previous findings (Ali et al., 2010; Bringard et al., 2006). Taking into account the results of previous studies and the present work, we demonstrated that running with GCS during three weeks did not influence cardiorespiratory parameters in runners.

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## CARDIOVASCULAR RESPONSE ACCORDING TO DRILL SPECIFICITY IN PROFESSIONAL BASKETBALL PLAYERS

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### INTRODUCTION

The aim of this study was to determine how different basketball drills affects the internal workload (heart rate; HR) depending on specificity of the confrontation format, related to the number of players (equality: 2v2, 3v3, 4v4, 5v5; and superiority: 2vX and 3cX) and the pitch size (full court, 1c; more than 1c consecutively, Xc) (Schelling and Torres-Ronda, 2013) in professional basketball players.

### PROMEDIO METHODS

Thirteen professional basketball players from Spanish 1<sup>st</sup> Division (age: 25.5±4.7 y; height: 198.8±8.8 cm; weight: 93.3±12.8 kg) participated in the study. HR was recorded during every training session along the whole season. A 3-week period of training was randomly selected, which included a total of 137 exercises. Differences in cardiovascular response (Heart rate mean, HR<sub>mean</sub> -bpm-; relative to players' maximal HR, %HR<sub>max</sub> -%-) amongst the basketballs drills were compared using the Cohen's *d* (*d*) as Effect Size indicator, with 95% Confidence Interval.

### RESULTS

The main results showed greater HR responses for the 'superiority' exercises (2vX and 3vX; 1c and Xc; ~4.5-min) and 'scrimmage' (5v5; Xc; ~7.1-min), [HR<sub>mean</sub>: 156.8±11.5 and 149.2±20.0, respectively; %HR<sub>max</sub>: 75.8±5.6 and 72.1±9.6,

respectively] than in small-sided games in numerical equality (2v2 and 3v3; 1c and Xc; ~4.6-min; and 4v4; 1c; ~7-min) [HR<sub>mean</sub>: 141.4±17.5 and 133±21.1; %HR<sub>max</sub>: 68±8.0 and 64.4±5.6, for 2v2+3v3 and 4v4, respectively]. The differences in HR responses (HR<sub>mean</sub> and %HR<sub>max</sub>) between drills were from small to large: 2v2+3v3 vs Superiority (*d*: -1.04, -1.14, respectively), 2v2+3v3 vs 4v4 (*d*: 0.43, 0.54, respectively), 2v2+3v3 vs 5v5 (*d*: -0.42, -0.46, respectively), Superiority vs 4v4 (*d*: 1.40, 2.07, respectively), 4v4 vs 5v5 (*d*: 0.78, 0.99, respectively).

### CONCLUSIONS

The results suggested that 'scrimmage' is the most demanding exercise. Findings also revealed that playing in 'superiority' elicited higher cardiovascular demands than in numerical equality. Despite less specificity than a real game or scrimmage, 2v2 and 3v3 (Xc) exercises should be preferred to 4c4 (1c) for a better conditioning development. This study provided practical information on how to use different basketball drills depending on physiological and conditioning aims.

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## ACUTE EFFECTS OF STATIC STRETCHING AND WHOLE-BODY VIBRATION AS WARM-UP ON KAYAKING START PHASE TIME

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### INTRODUCTION

The start phase in sprint kayak racing is a great percentage of the race success. Thus, a proper warm-up is required to get ready for the competition, but there is a lack of agreement about the effect of including stretching or vibration during the warm-up. The purpose of this study was to examine the acute effects of static stretching (SS), whole body vibration (WBV), SS plus WBV (SS+WBV) and only general warm-up (C) prior to a 12-m kayak sprint.

### METHODS

Ten elite kayakers (8 men and 2 women) with international competitive level in flat water events volunteered for the study. After a general warm up, the subjects performed a specific warm-up protocol during 4min 30s: SS (20s each stretching), WBV(50Hz, 2.51mm peak-to-peak), SS+WBV or C. Specific warm-up protocols were randomly applied one per week during 4 weeks. Then, a 12-m maximum kayak sprint from a stationary start was performed. All paddlers began after the signal with the left blade submerged. Tests were performed in a dew pond, using a linear position transducer recording the split time at 2, 5 and 10m.

### RESULTS

Time to achieve 2m after SS protocol was significantly lower compared with WBV (-7.4%;  $p = 0.041$ ;  $d = 0.46$ ) and SS-WBV (-8.9%;  $p = 0.05$ ;  $d = 0.54$ ). Likewise, time to achieve 5m was lower after SS in respect to WBV (-5.1%;  $p = 0.04$ ;  $d = 0.39$ ) and SS-WBV (-5.8%;  $p = 0.05$ ;  $d = 0.44$ ). However, no differences were observed in time to achieve 10m after the application of any protocol.

### DISCUSSION

As it has been observed in previous studies (1), the inclusion of short duration stretching exercises within the warm-up (<30s per muscle) may not affect negatively in subsequent performance, especially if the population is highly trained. Although a positive effect induced by WBV on upper limb performance has been demonstrated when the stimulus is applied during the exercise, when WBV is applied 60s prior to the performance there is no benefit (2). According to Yapicioglu et al. (3) it seems that SS or SS+WBV have not any negative or positive effect before performing explosive actions. In conclusion, the inclusion of WBV in the warm up of elite kayakers does not provide any benefit in comparison with the inclusion of static stretching

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## MEAN VELOCITY IN ACCELERATION PHASE OF TRUNK ROTATIONS TO THE DOMINANT AND NON-DOMINANT SIDE IN GOLFERS AND TENNIS PLAYERS

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### INTRODUCTION

Trunk muscles (erector spinae, abdominal oblique, and rectus abdominis) are particularly active during the acceleration phase of trunk rotations (e.g., the golf swing) with the trial-side abdominal oblique muscles showing the highest level of activity (1). However, to which extent the asymmetric loading of trunk muscles in sports such as golf, tennis, or hockey causes side-to-side differences in trunk rotation velocity has not been specified. Therefore, mean velocity in acceleration phase of trunk rotations to the dominant and non-dominant side in golfers, tennis players and control subjects was compared.

### METHODS

Group of 16 golfers (age  $24.1 \pm 3.7$  years, height  $178.5 \pm 6.7$  cm, weight  $86.8 \pm 10.2$  kg), 14 tennis players (age  $21.5 \pm 1.2$  years, height  $181.4 \pm 5.3$  cm, weight  $82.8 \pm 7.8$  kg), and 30 control fit individuals (age  $21.7 \pm 0.8$  years, height  $179.5 \pm 4.7$  cm, weight  $80.8 \pm 8.8$  kg) performed 5 rotations of the trunk to each side in a seated position with barbell of 1 kg and 20 kg placed on the shoulders. The FitRO Torso Dynamometer was used to monitor basic biomechanical parameters involved in exercise. The system measures angular velocity and calculates circumferential velocity, as follows:  $v_{\omega} = (\omega/360) \times 2\pi r$ , where  $\omega$  is the angular velocity, and  $r$  is the turning radius.

### RESULTS

Golfers showed significantly higher mean velocity in the dominant than non-dominant side with 1 kg ( $393.1 \pm 79.5$  vs.  $360.7 \pm 63.9$  °/s,  $p = 0.047$ ) but not with 20 kg ( $156.5 \pm 29.6$  vs.  $154.7 \pm 25.5$  °/s,  $p = 0.547$ ). However, tennis players demonstrated significantly higher mean velocity in the dominant than non-dominant side with both 1 kg ( $442.8 \pm 87.9$  vs.  $394.7 \pm 80.3$  °/s,  $p = 0.017$ ) and 20 kg ( $197.8 \pm 39.7$  vs.  $164.6 \pm 31.2$  °/s,  $p = 0.048$ ). On the other hand, no significant side-to-side differences in mean velocity in acceleration phase of trunk rotation with weight of 1 kg ( $377.1 \pm 75.4$  vs.  $354.7 \pm 71.1$  °/s,  $p = 0.378$ ) and 20 kg ( $150.7 \pm 28.4$  vs.  $150.4 \pm 29.3$  °/s,  $p = 0.655$ ) in fit counterparts were found.

### DISCUSSION

Taking into account no significant side-to-side differences in mean velocity in acceleration phase of trunk rotation in control fit individuals and its higher values in the dominant than non-dominant side in golfers with 1 kg and tennis players with 1 and 20 kg, this parameter may be considered specific to asymmetric loading of trunk rotation.

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## EVOLUTION OF THE LATERAL SYMMETRY OF THE LOWERS LIMBS OF PROFESSIONAL FOOTBALLERS DURING THE SEASON

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### INTRODUCTION

Tensiomyography (TMG) as a non-invasive method of neuromuscular assessment, can be relevant to establish the monitoring of the athlete throughout the season, showing how his muscles react and accept particular training and competition loads, as well as be used as reference values of a certain competitive level (1,3). In addition, it has been used to determine the lateral and functional symmetry of the athletes (2).

### METHODS

Forty footballers belonging to two professional soccer teams of the Spanish League were tested in three different periods of the season. The contractile properties of vastus-medialis (VM), vastuslateralis (VL), rectus femoris (RF), and biceps femoris (BF) of both legs were determined by TMG. The parameters were registered following the assessment protocol indicated by García-García et al. (1). The lateral symmetry percentages (LS) were calculated following the algorithm, which implements the software TMG-BMC tensiomyography®, where time contraction and maximum radial displacement of muscle are most important parameters. One-way ANOVA with bonferroni test ( $p \leq 0.05$ ) was implemented having into account the period of the season as an independent factor. The Intra-class correlation coefficient (ICC) was also calculated.

### RESULTS

The sample analyzed is normal. It has been found an ICC above 0.8 in all the muscles tested. No significant

differences have been found between both legs. LS of VM ( $92.5 \pm 2.7\%$  vs  $85.1 \pm 8.9\%$  vs  $89 \pm 6.4\%$ ;  $p=0.009$ ) and RF ( $84.3 \pm 9\%$  vs  $90.2 \pm 6.3\%$  vs  $86.7 \pm 6.9\%$ ;  $p=0.05$ ) show variations along the three periods of the season.

### DISCUSSION

These findings are in line with the lack of significant differences between both legs of professional volleyball players (4) and of professional cyclists (1), tested with TMG. It has been suggested that the lack of significant differences between both sides, when the percentage of LS determined by software TMG is above to 80%, it could be considered as appropriate (2).

The LS percentages of VM and RF vary throughout the season; however, it has not been found any pattern in this variation.

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## EFFECT OF AN ACTIVATION PROTOCOL BASED ON POSTACTIVATION POTENTIATION ON SWIMMING START PERFORMANCE

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### INTRODUCTION

There is a potentiation method called Postactivation Potentiation (PAP) which is based on the application of near maximal loads, conducted prior to the exercise performance, which improves the ballistic movement (Tillin & Bishop, 2009). The purpose of this study was to compare the effect of an activation protocol on swimming start performance (SS).

### METHODS

Fourteen trained volunteer swimmers participated in the study. An intra-group design of randomized repetitive measurements was applied. A previous standard SS trial after a standard warm up served as reference (P1). One method of activation was applied: Four repetitions in the flywheel YoYo Squat (P2). Kinematic variable of SS were collected using video analysis

### RESULTS

After P2, the subjects achieved a higher mean horizontal velocity during the flight (VxH) ( $4.89 \pm 0.12$  m/s) than after P1 ( $3.63 \pm 0.11$  m/s) ( $p < 0.001$ ). After P2, it took the subjects less time to cover a distance of five meters (T5m) ( $1.65 \pm 0.052$  sec) compared to P1 ( $1.75 \pm 0.057$  sec) ( $p \leq 0.001$ ).

### DISCUSSION

The use of the flywheel device was based on two clear objectives: taking advantage of the high lower limb acti-

vation which provokes potentiation; and the possibility to execute an activation gesture almost identical to the real action. The results obtained in this study are clear evidence that an improvement of the peak forces occurred on the block as was observed by Breed and Young (2003). We observed that VxH ostensibly improved, which means that the swimmer's flight was longer and faster. T5m also showed to be shorter after P2 application, suggesting that take-off potentiation provokes that swimmer enter into the water with more velocity. These results suggest that a warm up based on the PAP by repetitions on the flywheel improves the SS.

### ACKNOWLEDGEMENTS

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## LOW SPEED ENDURANCE TRAINING VOLUME PRODUCES MORE ANAEROBIC CAPACITY GAINS THAN HIGH VOLUME

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### INTRODUCTION

Speed endurance production training, is a powerful stimulus for team sports players by increasing their anaerobic capacity. Generally 3-12 bouts about 40 s at 70-100% of the maximum speed, with a 1:5 exercise: rest ratio (1). But there is no research on the differences that may exist in applying different workloads. The aim of the present study was to compare the performance effects produced by 4 weeks of different volumes of speed endurance training (SET) in soccer players during the season, and to investigate the changes through this different training in jumping ability, and metabolic response.

### METHODS

Twelve semi-professional soccer were randomly assigned to either high volume training (HVT) (8-10 rep) or low volume training (LVT) (4-5 rep), and performed one session a week an addition training consisted of all out 30-s runs, which includes parts with ball and changes of directions, with 3 minutes of rest, during 4 weeks. Before and after the training intervention, players completed a Yo-Yo Intermittent Recovery Test Level 2 (Yo-Yo IR2), sprint test and countermovement jump (CMJ)

### RESULTS

A related samples t-test was used to analyse Yo-Yo IRT-2 performance pre-post SET training as well as to analyse acute effects of pre- and post- specific SET training session with CMJ and lactate changes. Yo-Yo IRT-2 performance improved significantly for two groups ( $p < 0.001$ ) showing a surprisingly higher improvement in the LVG (pre 540

$\pm 115\text{m}$  – post  $683 \pm 153\text{m}$ ; 26.5%;  $p < 0.01$ ; effect size (ES) 1.04) compared to the HVG (pre  $544 \pm 163\text{m}$  – post  $616 \pm 184\text{m}$ ; 13.2%;  $p < 0.05$ ; ES 0.41) in Yo-Yo IRT-2. No significantly performance differences were found in sprint test and CMJ. Acute mechanical effects measured as CMJ height loss pre-post specific SET training session as average was significant (7.2%), and fatigue, measured as CMJ height loss, was significant for two groups, respectively ( $p < 0.01$ ;  $p < 0.05$ ) showing a higher decrement in the HVG (8.5%;  $p < 0.01$ ; ES 0.93) compared to the LVG (5.5%;  $p < 0.05$ ; ES 0.62) and was correlated to lactate ( $r = 0.9$ ) in each subject, checking that values were moderate in LVG ( $5.95 \text{ mmol}\cdot\text{L}^{-1}$ ) and large in HVG ( $8.74 \text{ mmol}\cdot\text{L}^{-1}$ ).

### CONCLUSIONS

These findings suggest that low-volume SET training, although required a reduced workload, produced better performance effects than high-volume in 4 weeks. In addition it entails a significant reduction in the amount of training and players undergo less fatigue, allowing an early recovery. In summary, the present study showed that in trained soccer players an addition of one weekly SET session during 4 weeks, elevated anaerobic capacities, and also suggest that it is not necessary to carry large volumes to find performance improvements.

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## EFFECTS OF POSTACTIVATION POTENTIATION ON POWER OUTPUT AFTER HIGH AND LOW INTENSITY OF SQUAT EXERCISE

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### INTRODUCTION

It is widely accepted that contractions of maximal or near maximal intensity optimize postactivation potentiation (PAP) (1). It is still insufficient evidence to apply for PAP for sports activity because muscle fatigue and enhancing effect are present at the same time during heavy load exercise (2). It is unclear whether the effect of PAP is appeared by light load and how long the effects are remained. The purpose of the present study was to examine the effects of PAP on muscular strength and power after the different intensity of squat exercise and how long that effects are remained.

### METHODS

Eight healthy athletes (21±2 years old), with a minimum of 2-years experience in resistance training, were volunteered in this study. After one repetition maximum (1RM) test, the subjects carried out heavy squat (80% of 1RM) until no longer keep up with the rhythm (2s down and 2s up). The number of times of execution of the 40% of 1RM squat exercise was set to double that for the same amount of work was carried out at 1RM of 80%. Loaded (30% of 1RM) counter movement jump (LCMJ) was performed before and after 1, 3, 5, 10, 20 min.

### RESULTS

The magnitude increase in height of LCMJ was no difference between 40% of 1RM and 80% of 1RM squat exercise. However, an increase in power output after 80% of 1RM preload was remained longer than that of 40% of 1RM.

### DISCUSSION

Young et al (3) have reported a significant increase in jump height of the counter movement jump (2.8%) multiplied by the load of 19kg after high conditioning contraction (a squat 5RM). However, the power output during LCMJ increased significantly after not only heavy (80% of 1RM) but also light (40% of 1RM) conditioning contraction in this study. However, it is likely that the same amount of work by 40% of 1RM increase power output. This may be because longer muscle activity would produce more recruitment MU activity even though at 40% of 1RM.

### FINANCIAL SUPPORT

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## ACTN3 R577X POLYMORPHISM IN MARATHON ATHLETES

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### INTRODUCTION

The effect of the *ACTN3* genotype has mainly been studied in elite athletes, based on the hypothesis that its influence on muscle function would be most readily observable at the extremes of human performance. The X allele tends to be overrepresented in those humans with an 'extreme endurance phenotype', i.e. elite endurance athletes (1-2). The aim of this study was to examine the genotype distribution of the R577X polymorphism (rs1815739) in  $\alpha$ -actinin-3 (*ACTN3*) gene among marathon athletes.

### METHODS

Participants of the study were 173 men athletes with best personal time <3h in marathon (mean age=43.06 years). The control group consisted of 216 non-athletes male young adults (mean age=20.73 years). Genotyping was performed by polymerase chain reaction. We used the chi-square test to determine whether the genotypic frequencies of the *ACTN3* R577X genotypes differed between groups and logistic regression to calculate the odds ratio for being a marathoner based on the aforementioned genotypes. The SPSS 18.0 program was used for all statistical analyses.

### RESULTS

Genotype allele frequencies were similar between marathon athletes and control groups ( $P>0.05$ ). We did not find an association between the *ACTN3* R577X polymorphism and the likelihood of being an athlete marathon using the dominant (RR vs. RX+XX) and the recessive model (RR+RX vs. XX).

### DISCUSSION

The *ACTN3* R577X polymorphism is not associated with marathon athlete status, at least in the cohort we studied. These results were theoretically unexpected, given the role of  $\alpha$ -actinin-3 on skeletal muscle phenotypes, particularly muscle endurance and the importance of this phenotype for marathon performance.

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## CARDIOMETABOLIC RESPONSES TO A BATTLING ROPE HIGH INTENSITY INTERVAL TRAINING PROTOCOL

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### INTRODUCTION

Battle rope training, consisting on vigorously undulating a rope with the upper body, has become a popular cardiovascular training choice, due the growing popularity of Extreme Conditioning Programs (ECPs; e.g. Crossfit, Insanity, Elements™, and others) (1). Despite widespread use, little is known about the cardiometabolic demands of battle rope training (2, 3).

### METHODS

Eight healthy and physically active male (age=30.4±4.2 years, height=1.76±0.05 m, body mass=77.1±9.3 kg, fat mass=15.53±6.35 %), with no history of upper body or trunk injury in the last six months, completed a treadmill test for maximal oxygen uptake. On the second testing session, subjects completed a battle rope interval training protocol, similar to those used by Tanisho et al. (4): 10 sets of 10-second maximal effort of double arm waves, with 20-second recovery periods. They used a 15m rope anchored to a post, resulting in the participant holding 7,5m of rope in each hand. A Wilcoxon Test was used to compare the different measurements assessed in both, treadmill test and battle rope interval training protocol. Values of  $p < 0.05$  were considered statistically different.

### RESULTS

The average heart rate for the workout (175±10 bpm) was significantly lower than the maximum heart rate (189±9 bpm), representing the 93.5±2.1% of it ( $Z = -2.10$ ;  $p = 0.036$ ). In addition, the average peak  $\text{VO}_2$  for the work-

out ( $46.2 \pm 4.1 \text{ ml} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$ ), was significantly different from the maximum  $\text{VO}_2$  ( $53.0 \pm 4.6 \text{ ml} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$ ), representing the 87.2±10.5% of it ( $Z = -2.521$ ;  $p = 0.012$ ).

### DISCUSSION

The results of this study suggest that an acute 5-minute interval protocol of battle rope training is a vigorous-intensity workout, resulting in very high heart rates. Our results are similar to those reported by Fountaine & Schmidt (2), and to other alternative modes of cardiovascular training used in ECPs, like kettlebell training. In a population similar to our study (5), a high intensity kettlebell workout, consisting of 35 second standard swing intervals followed by 25 seconds rest intervals, resulted in average heart rates of 180±12 bpm, average  $\text{VO}_2$  of 34  $\text{ml} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$ , and 52.3±10.5 kJ/min.

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## RELATIONSHIP BETWEEN TRUNK STABILITY AND TRUNK MUSCULAR FITNESS

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### INTRODUCTION

Although trunk muscular strength and endurance could be determinant of trunk/core stability (van Dieen et al., 2012), there is a lack of studies on the relationship between trunk muscular fitness and stability. The aim of this study was to analyze and describe this relationship in order to better understand which variables are more influential in trunk stability.

### METHODS

36 male recreational athletes participated in this study. Two different methodologies were used to assess trunk stability. A battery of static and dynamic tests was performed to measure trunk balancing while sitting on stable and unstable seats placed on a force plate (Kistler 9286A). Postural and dynamic sway were assessed by analyzing the mean radial displacement of the centre of pressure. Sudden and unexpected trunk loads in anterior, posterior and lateral directions were applied to the thorax by a pneumatic actuator, while the subject was seated with the pelvis fixed. Trunk angular displacement was measured and the damping and stiffness coefficients of the trunk were calculated from the first 110 ms of data. An isokinetic test, consisting of 4 trials of 15 maximal flexion-extension exertions at 120°/s (ROM = 50°), was used to assess trunk muscle fitness. Absolute and relative peak torque and maximum work were calculated to assess trunk strength; and endurance ratio, maximum work ratio and final fatigue ratio were used to assess trunk endurance.

### RESULTS

No correlations were found between trunk flexion and extension muscle fitness and trunk response to sudden perturbations, or between trunk flexion muscle fitness and trunk balance control while sitting. On the contrary, for the extensor muscles, higher absolute and relative peak torque and maximum work ( $-0.330 < r < -0.424$ ), and higher maximum work ratio were significantly related with lower error during sitting balance tasks.

### CONCLUSION

Our results suggest that the ability to generate higher extension forces in a short time (explosive strength) might facilitate the performance of quick postural adjustments during trunk balancing tasks (Izquierdo et al., 1999; Young & Metzl, 2010). In addition, trunk extensor endurance correlated with trunk balancing while sitting may be due to the length (70 s) and number of trials (18) executed during the battery of trunk balance tests.

### ACKNOWLEDGEMENT

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## THE PROGRESSIVE INCREASE IN BODY WEIGHT AFFECTS LEG STIFFNESS DURING HOPPING AT DIFFERENT FREQUENCIES

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### INTRODUCTION

During human locomotion, the overall stiffness of the lower limbs (leg stiffness,  $K_{leg}$ ) is directly related to the efficiency of the stretch-shortening cycle.  $K_{leg}$  represent the average stiffness of the musculoskeletal system during the ground contact phase (Farley & Morgenroth, 1999). In this sense, according to Kuitunen et al. (2011), a high stiffness of the leg optimizes power output and reduces metabolic costs, increasing athletic performance. However, further research is needed to know how training with weighted vest could affect  $K_{leg}$ . Furthermore, the aim of this study is to test the effect of different load conditions on leg stiffness during hopping performed at different frequencies.

### METHODS

The experiment consisted in a single session, in which both the hopping frequency and load percentage (independent variables) were randomly tested in order to know the effect on the  $K_{leg}$  (dependent variable) during a hopping task. Thirteen healthy male subjects ( $23.33 \pm 1.50$  yrs;  $68.09 \pm 5.92$  Kg;  $173 \pm 0.04$  cm) were required to perform two legged hopping. The hopping frequency (1.8, 2.2, 2.6 & 3.0 Hz) were established through a digital metronome. The different overload conditions were determined in relation to the body weight (0%, 5%, 10%, 15% & 20%) and were carried out through weighted vest. To test the effect on leg stiffness, a two way repeated measures ANOVA (load x frequency) was performed. The alpha level was set at  $p \leq 0.05$ .

### RESULTS

The ANOVA-RM showed a significant effect for frequency and load ( $p \leq 0.001$  and  $p \leq 0.05$ , respectively), and a significant interaction between both factors ( $p \leq 0.05$ ). The results demonstrated a significant increase of  $K_{leg}$  when hopping frequency is increased ( $p \leq 0.05$ ). However, the analysis revealed a significant effect of the different load conditions during hopping at 3.0 Hz. Under this condition (3.0 Hz),  $K_{leg}$  significantly increased when subjects wore weighted vest with 10, 15 and 20% of BW.

### DISCUSSION

Present study showed a significant increase of leg stiffness as the hopping frequency increase, associated with a decrease in contact time (Farley et al., 1991). This relationship between hopping frequency and leg stiffness remains for different overload conditions. Furthermore, the results showed a significant increase in leg stiffness due to overload, only when the hopping frequency is greater than or equal to 3Hz and loads higher than 10% of BW. Present result could be taken into account by those coaches and trainers when planning their training programs, if they seek specific effects on  $K_{leg}$ .

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## THE RELATIONSHIP BETWEEN NEUROMUSCULAR FORCE-VELOCITY CHARACTERISTICS AND PERFORMANCE INDICATORS IN COMPETITIVE DISTANCE RUNNERS

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### INTRODUCTION

Economy and peak velocity at  $\dot{V}O_2$  max ( $v \dot{V}O_2$  max) are now thought to be the main performance indicators in elite distance runners (1). Economy is the amount of metabolic energy expended at a given velocity.  $v \dot{V}O_2$  max ( $v \dot{V}O_2$  max) is the running velocity attained at the end of a maximum oxygen uptake test. In addition to cardiovascular output, economy and  $v \dot{V}O_2$  max are thought to be partly determined by the capacity of the neuromuscular system (2). The ground contact phase in running is the only phase in which the neuromuscular system produces force against the ground to horizontally propel the body. Neuromuscular ability can be assessed by measuring the force capabilities of the leg musculature at various velocities. Maximal-strength tests assess the ability of the leg extensors to produce maximal force during high-load, low or zero-velocity, movements (i.e. isometric mid-thigh pull). Reactive-strength tests assess the ability of the leg extensors to rapidly absorb and produce force during low-load, high-velocity movements (i.e. drop jumps), similar to those experienced in running. The purpose of this study was to examine the relationship between neuromuscular force capabilities (maximal and reactive-strength tests) and performance indicators (running economy and  $v \dot{V}O_2$  max) in competitive distance runners, thus providing the strength and conditioning practitioner with further evidence concerning the use of strength training for endurance athletes.

### METHODS

Twenty-six competitive club runners (age  $30.0 \pm 8.5$  years; height  $178.3 \pm 7.8$  cm; mass  $69.3 \pm 8.0$  kg and  $\dot{V}O_2$

$58.9 \pm 4.3$  mL/kg/min) were recruited from local running clubs. Each runner was assessed for economy,  $v \dot{V}O_2$  max, maximal-strength (isometric mid-thigh pull) and reactive-strength (30cm drop-jump).

### RESULTS

The results showed that there was no relationship ( $r = .03$ ) between isometric maximal-strength ( $36.5 \pm 7.7$  N/kg) and running economy ( $194 \pm 13.4$  mL/kg/km), but a significant moderate relationship ( $r = .349$ ,  $p = .04$ ) between maximal strength and  $v \dot{V}O_2$  max ( $20.3 \pm 1.9$  km/h) was exhibited. A weak relationship was found between reactive-strength index ( $1.1 \pm 0.3$ ) and running economy ( $r = .218$ ) and  $v \dot{V}O_2$  max ( $r = .289$ ),

### DISCUSSION

The results from this study suggest that there may be a small-moderate relationship between neuromuscular ability and specific performance indicators in competitive distance runners. However further research is needed to ascertain whether increasing maximal- and reactive-strength capabilities results in improved running performance.

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## EFFECTS OF 9 WEEKS STRENGTH + HIIT TRAINING ON ELDERLY COPD PATIENT'S FITNESS

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### INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is associated with a progressive decrease in strength and endurance, especially in the elderly (1, 2). Combined strength and endurance training has been demonstrated to improve exercise tolerance, muscle strength, quality of life, dyspnea and fatigue in COPD patients (3). High intensity interval training (HIIT) has been shown to be as effective as continuous endurance exercise in terms of cardiovascular and muscular adaptations (4). Therefore, the main purpose of this study was to investigate the effects of 9 weeks strength and HIIT training on muscular strength, physical fitness and body composition in elderly patients with COPD.

### METHODS

12 male COPD patients ( $83.7 \pm 2.9$  yrs;  $BMI=28.4 \pm 2.5$ ) from the geriatric hospital Virgen Del Valle were recruited. A cross over design was used. Subjects followed a 9 week strength + HIIT exercise program (2 sessions/wk, 45'/session). Maximal voluntary contraction (MVC) was measured by a dynamometer. Physical fitness was assessed by the standardized Senior Fitness Test (SFT) and body composition was assessed by a tanita bioimpedance system. Subjects' COPD level was calculated according to their Body mass index, airflow obstruction, dyspnea and exercise capacity (BODE index). The intervention will finish by the end of May 2014.

### RESULTS

Subjects were classified as COPD level  $1.6 \pm 0.7$  (low to moderate). Total body fat mass (FM) was  $31.2 \pm 4.8\%$ ,

whereas fat free mass (FFM) was  $49.3 \pm 3.7$ kg. Mean MVC was  $10.1 \pm 3.6$ kg for arm abduction,  $15.6 \pm 5.1$ kg for hip flexion and  $12.2 \pm 2.3$ kg for leg extension. According to the SFT, upper extremities strength had a score according to percentile 10 of an age-matched Spanish population (P10), (5) ( $9.5 \pm 5.2$  reps), flexibility for upper and lower extremities were  $19.8 \pm 7.7$  and  $14.4 \pm 9.0$  cm, corresponding to a reference P40 and P30, respectively; lower extremity strength had a score of P30 ( $11.5 \pm 3.6$  times) and agility levels corresponded to P40 ( $8.1 \pm 1.5$  s).

### DISCUSSION

Overall, our SFT results were lower than other age-matched studies (5). We expect to improve body composition and physical fitness according to Franssen et al (1). 50-100% improvements of the 1 RM test for all weight lifting exercises are also expected. Accordingly, MVC will be increased by 30-50%. Finally, we expect to significantly improve all components of the SFT. In conclusion, due that COPD patients show severely compromised exercise capacity and are limited by ventilatory constraints, strength + HIIT training could be an effective way to prescribe exercise in this specific population.

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## FUNCTIONAL FITNESS AND BODY COMPOSITION IN THE SPANISH ELDERLY

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### INTRODUCTION

The aging process is accompanied by large changes including decreased functional fitness (FF) (1), increased fat mass (2), and a decline in muscle mass and strength (3). However, the relationship between the level of functional fitness and some body composition variables such as overweight and obesity (OO), central obesity (CO), sarcopenic obesity (SO) and dynapenic obesity (DO) has not yet been researched in a Spanish sample of older adults.

### METHODS

A cross-sectional study was conducted with 514 subjects aged greater than 64 years old living in Castilla-La Mancha (Spain). To measure FF the subjects completed the Senior Fitness Test (SFT) (1). They were classified into three groups according to the SFT criterion cutoffs (4): at risk for loss of functional mobility (FM), pre-risk for loss of FM and without risk. The analysis of body composition was carried out using standardized techniques and equipment (5).

### RESULTS

Prevalences of OO, CO, SO and DO was 72.6%, 63.7%, 15.5% y 13.5%, respectively. A decreased FF was significantly associated with higher prevalence of OO, CO, SO and DO ( $p=0.000$ ) showing the group at risk for loss of FM the highest values in all variables (92%, 88.5%, 24%, y 66.7%, respectively).

### DISCUSSION

Prevalences of OO, CO, SO and DO were increased with a declined FF. This is similar to other reported findings, where the subjects with SO (6) and DO (7) showed poorer scores in FF than healthy subjects. In conclusion, it appears that maintaining adequate levels of FF protects older adults from increased risk for OO, CO, SO and DO.

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## SEX DIFFERENCES IN RESISTANCE TRAINING INJURIES DURING A WEIGHT LOSS PROGRAM

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### INTRODUCTION

The recent increase in participation of women in sport has led to a resultant increase in injuries in this population (1). In the last years, strength training has become more popular due to the latest findings showing that this type of training is beneficial to health including for weight loss programs (2-4). However, few studies have examined the sex differences in resistance training-related injuries.

### METHODS

One hundred and twelve people (59 women and 53 men) with a body mass index between 25 and 34.9 kg/m<sup>2</sup>, and aged from 18 to 50 years, participated in a 6-month resistance training intervention, while following a caloric restriction between 25-30% from total daily energy expenditure. Chi-square analysis was used for the initial comparison of the proportion of injury and sex. Logistic regression was used to further elucidate the sex differences and to estimate the odds ratio (OR) and its associated 95% confidence interval (CI).

### RESULTS

Comparisons between the sexes for injury with resistance training showed that there was no related in OR for injuries between men and women ( $p > 0.01$ , OR=1.41: 95% CI=0.65 to 3.01). During the 6-months program, 67 subjects reported any kind of injury (49.3% from women and 50.7% from men).

### DISCUSSION

Women and men are injured at the same rate and there are no significant relationships between sex, resistance

training and injury when volume, time and intensity of training are controlled and monitored (5). Different results were obtained by Quatman et al. (2009) which demonstrated that during strength training activities, women had a higher risk of accidental injuries and suffered more lower extremity injuries compared to men ( $p < 0.001$ , OR = 1.69; 95% CI = 1.37 to 2.08). Men, however, suffered more exertional-type resistance training injuries such as sprains and strains compared to women ( $p < 0.001$ , OR = 1.55; 95% CI = 1.25 to 1.96), particularly at the trunk (1). Probably these results are due to a different sample size between men and women and future works should focus on the determination of whether the number of injuries is similar for both sexes when training sessions have the same intensity, volume, effort perception and the number of women and men is similar. (Clinical Trials gov number: NCT01116856).

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