

## ORAL ABSTRACT PRESENTATION

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### A COMPARISON BETWEEN HEART RATE AND POWER OUTPUT TO PRESCRIBE EXERCISE INTENSITY

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**Introduction:** Exercise intensity can be prescribed based on internal (e.g., heart rate [HR]) or external variables (e.g., power output [PO]). However, these variables may be affected by different aspects like environmental temperature or nutritional status (1). Thus, the purpose of this work was to analyse the possible changes in HR and PO under different situations: control, glycogen depletion (GD) and hyperthermia. **Methods:** Four women ( $61.6 \pm 3.9$  kg;  $166.1 \pm 6.6$  cm;  $23.6 \pm 2.9$  years) and 8 men ( $70.7 \pm 5.2$  kg;  $175.48 \pm 2.2$  cm;  $21.73 \pm 2.9$  years) performed an incremental exercise test on a cycle ergometer (Lode Excalibur, Germany) in 3 situations: control, GD and hyperthermia ( $\sim 36^\circ\text{C}$ ). The test started at 30 W with 30 W increase every 3 min until exhaustion. HR and breathing exchange were monitored constantly using a gas analyser (Jaeger, CareFusion, Germany). First (VT1) and second (VT2) ventilatory thresholds were determined as previously described (2). HR and PO at VT1 and VT2 were compared between situations using a 2-way repeated measures ANOVA and Bonferroni as post hoc. The effect size was calculated by partial eta-squared ( $\eta_p^2$ ). **Results:** A significant main effect of situation was observed in PO ( $p = 0.005$ ;  $\eta_p^2 = 0.353$ ). PO was significantly higher in control (VT1:  $115.21 \pm 35.06$  W; VT2:  $185.83 \pm 31.29$  W) compared to hyperthermia (VT1:  $95.58 \pm 39.98$  W; VT2:  $166.25 \pm 29.22$  W;  $p = 0.011$ ), whereas it was significantly higher in GD (VT1:  $117.50 \pm 26.44$  W; VT2:  $189.42 \pm 27.54$  W) compared to hyperthermia (VT1:  $95.58 \pm 39.98$  W; VT2:  $166.25 \pm 29.22$  W;  $p = 0.046$ ). In contrast, it was not found a significant effect of situations in HR

(VT1 control:  $132 \pm 20$  bpm; VT1 depletion:  $130 \pm 16$  bpm; VT1 hyperthermia:  $129 \pm 19$  bpm; VT2 control:  $158 \pm 17$  bpm; VT2 depletion:  $152 \pm 26$  bpm; VT2 hyperthermia:  $158 \pm 15$  bpm;  $p = 0.354$ ;  $\eta_p^2 = 0.109$ ). **Conclusion:** PO at VT1 and VT2 appears to change between situations while HR does not seem to be affected, supporting previous results (1). Therefore, if the objective is to stimulate a metabolic pathway it is recommended to prescribe exercise intensity based on an internal variable, such as HR, to induce the same metabolic stimulus. However, if the purpose is to analyse changes in performance, we suggest observing mechanical variables, such as PO at the VT1 and VT2. Nevertheless, more research is needed to further investigate the relationship between these variables and whether these differences would be maintained in steady states.

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### EFFECTS OF SHORT-TERM DETRAINING PERIOD ON STRENGTH AND JUMP PERFORMANCE IN SEMI-PROFESSIONAL FEMALE HANDBALL PLAYERS

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**Introduction:** The concept of “short-term detraining” was defined as a period less than 4 weeks in which training is reduced or interrupted [1]. In handball, several studies have examined the effects of short- and long-term training programs [2,3]. However, the impact of detraining periods on physical and physiological performance factors have been little investigated, specifically in female players. Thus, the aim of this study was to analyze the effects of 3 weeks of detraining on strength and jump performance in semi-professional female handball players. **Methods:** Fourteen semi-professional female handball players (age:  $20.5 \pm 3.0$  years; height:  $167.3 \pm 6.1$  cm; body mass:  $66.9 \pm 8.8$  kg) from the same team performed 3 trials of the countermovement jump (CMJ) and isometric mid-thigh pull (IMTP) on a previously validated portable force plate [4] during 2 separate testing sessions. Normality of data was confirmed

using the Shapiro–Wilk test. A paired *t*-test was used to assess the differences between testing sessions in CMJ jump height (cm) and IMTP peak force (N) and RFD 0–250 ms ( $N \cdot s^{-1}$ ). Statistical significance level was set as  $p \leq 0.05$ . **Results:** Players showed a significant decrease in CMJ jump height ( $28.68 \pm 3.71$  vs.  $25.92 \pm 3.75$  cm;  $p < 0.001$ ) and no significant differences in IMTP peak force and RFD 0–250 ms were found after the short-term training interruption ( $p = 0.288$ ;  $p = 0.139$ , respectively). **Discussion and Conclusion:** These results suggest that 3 weeks of detraining is insufficient to produce a significant decrease in force production (maximal and explosive), although is sufficient to induce a significant decrease in jump height. This reduction in CMJ jump height could be explained by 2 reasons: (i) a significant decline in eccentric force [1] and (ii) an alteration of technique factors [5]. This information may help technical staff to design appropriate training interventions to enhance performance after a training cessation period.

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## HIGH FOOD-SPECIFIC IGE ANTIBODY REACTIONS IN OLDER SPANISH ADULTS WITH GOOD PHYSICAL FITNESS

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**Introduction:** Type I hypersensitivity is a IgE-mediated food and beverage adverse reaction to foodstuffs that can be measured using food-specific IgE antibody reactions (AbR) (1). It affects almost 5% of the adult population in developed countries (2). The aim of this study was to analyze food-specific IgE AbR in Spanish adults according to their physical fitness (PF). **Methods:** Two hundred sixty-three Spanish adults older than 18 years old volunteered for the study. PF was determined through the Åstrand-Ryhming Step Test (stÅ-R) (3). Subjects were classified in  $\leq 45$  years and  $> 45$  years; normal PF ( $< 85\%$  predicted  $VO_2\max$ ) and good PF ( $\geq 85\%$  predicted  $VO_2\max$ ). Food-specific IgE AbR against 41 food allergens were determined through HELIA®-HELMED® Line Immunoassay (AESKU.GROUP, Wendelshheim, Germany). IgE positive AbR were considered as  $\geq 3.5$  kU/l. Statistical analysis was performed using IBM-SPSS® Statistics software v.25.0. Odds ratio (OR) were used as a measurement of association and random-effects risk model. Statistical significance was set at 0.05. This study was approved by the Ethics Committee of the Universidad Politécnica de Madrid (ref. 20200602) and registered on ClinicalTrials.gov (NCT05802017). **Results:** A total of 263 sample (60.1% females) with: age  $43.5 \pm 12$  years; body mass index (BMI)  $24.42 \pm 4.51$  kg/m; and estimated  $VO_2\max$   $39.37 \pm 9.86$  ml/kg  $\times$  min (Mean  $\pm$  SD), were analyzed. Positive IgE AbR for normal vs good PF were 25.4% and 31.20%, respectively ( $p > 0.05$ ). Positive IgE AbR for young adults vs older adults with good PF were 25.3% and 30.9% ( $p < 0.05$ ), respectively. It was 2.30 times more likely to have nut allergy when belonging to the group of good PF and being  $> 45$  years (OR:2.30; CI:0.85–2.90,  $p > 0.05$ ). However, none of the moderator variables (age, sex and PF) represented a significant epidemiological risk factor over the food-specific IgE AbR ( $p > 0.05$  all cases). **Conclusion:** Total food-specific IgE AbR were not different across the established categories of PF. However, age was an influencing variable of contrast between young adults and older adults. PF represents neither a risk factor nor a protective factor, these singularities are observed both in the total IgE AbR and in the IgE AbR against all studied food groups.

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## SPORT SUPPLEMENTS WITH POSSIBLE ERGOGENIC EFFECT ON WOMEN SWIMMERS

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**Introduction:** Differences above 1.6% distance a gold medal from a fourth position in a final of the Olympic Games in swimming. Competitive swimmers present a prevalence of 86.9% in the consumption of sport supplements (SS) without differences based on sex (1). Possible ergogenic effects of SS are mediated by mechanical and metabolic demands of each sport modality (2). In addition, it exists differences at anatomical and physiological level based on sex who could explain differences on the possible ergogenic effect of SS. Recently, it has been reported an underrepresentation of women athletes in the studies which assess the effect of SS (3). Therefore, the aim of this study was to analyse the effect of different SS in female swimmers. **Methods:** This systematic review/meta-analysis was performed following the PRISMA guidelines. A search strategy that combined “supplement\*” and “ergogenic aid” with “aquatic sport,” “swimming” and “swimmers” was inserted in 5 different databases (Dialnet, DOAJ, Pubmed, Scielo, Scopus and SportDiscus). Two researchers independently (with a third for solving discrepancies) selected studies that assessed the effect of SS on swimming performance in studies that included women in the sample. In SS with at least 3 studies, a meta-analysis was performed. **Results:** From 3036 articles, only 23 studies were focused in the assessment of SS on performance in swimmers. However, only in 16 studies the sample included women (38.2% women vs. 61.8% men). Meta-analysis was applied to 3 groups of SS (creatine, beetroot juice, and  $\beta$ -alanine and sodium bicarbonate). Meta-analysis reported a significant effect of creatine in swimming performance ( $ES = -0.54$  (from  $-0.95$  to  $-0.13$ );  $p = 0.01$ ), but no effect was found for beetroot juice ( $ES = -0.14$ ;  $p = 0.42$ ) and  $\beta$ -alanine and sodium bicarbonate ( $ES = -0.12$ ;  $p = 0.48$ ). **Discussion:** The results of this study reflected an underrepresentation of women of studies focused on the assessment of the effect of SS in swimmers. This study concluded that creatine supplementation should be considered as ergogenic aids in women swimmers, while it could be found a non-significant effect of other SS (i.e., beetroot juice,  $\beta$ -alanine

and sodium bicarbonate), which could be more extensive studied in the future for creating specific recommendations based on scientific evidence.

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## EFFECTS OF L-CARNITINE AND ALPHA-LIPOIC ACID SUPPLEMENTATION ON ANAEROBIC PERFORMANCE DECAY UNDER FATIGUE CONDITIONS

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**Introduction:** AlcaLip<sup>®</sup> is a commercial nutritional supplement composed of alpha-lipoic acid and acetyl-L-carnitine (1). Acetyl-L-carnitine could have positive effects on high-intensity exercise performance (2) and alpha-lipoic acid have shown to reduce exercise-related oxidative stress (3). In the cycling field, there is growing evidence showing that the ability to maintain power output under fatigue conditions makes a difference between cyclists (4). The main aim of this study was to determine the effects of 4 weeks of supplementation AlcaLip<sup>®</sup> on anaerobic performance deterioration and lactate concentration between fresh and under fatigue conditions. **Methods:** Forty-one highly-trained male cyclists (age:  $36 \pm 12$  y.o.; BMI:  $23.11 \pm 2.49$  kg/m<sup>2</sup>) were randomized into 2 different groups: placebo group (PLA;  $n = 22$ ), and AlcaLip<sup>®</sup> group (ALC;  $n = 19$ ) that took 2250 mg/day of AlcaLip<sup>®</sup>. Before (PRE) and after 4 weeks (POST) of intervention, subjects performed 2 Wingate tests: with no previous fatigue (WG1), and immediately after a maximal graded exercise test (WG2). The power output decrement for mean power (PAVG) and peak power (PMAV) was assessed as the difference between WG1 and WG2 expressed as a percentage of the first, and calculated according to the equation  $[(WG2 - WG1)/WG1] \times 100$ . Lactate concentration was measured 3 minutes after each Wingate test. **Results:** Mean power was significantly lower under fatigue conditions ( $p = 0.011$ ) for ALC, while no fatigue effect was observed for PLA ( $p = 0.106$ ). Peak power was significantly higher under fatigue conditions ( $p = 0.006$  and  $p = 0.034$ ) for ALC and PLA respectively. However, there was no significant

group-time interaction on PAVG decay ( $p = 0.235$ ) neither on PMAV increase ( $p = 0.542$ ). A significant group-time interaction was observed for the lactate concentration measured after the WG2 ( $p < 0.038$ ;  $\eta_p^2 = 0.094$ ). Lactate concentration was  $1.6 \pm 0.6$  mmol/L lower in POST compared to PRE for ALC group. **Discussion:** Four weeks of supplementation could not be sufficient to improve the impairment of anaerobic performance under fatigue conditions, despite the reduction in blood lactate accumulation. Further research is needed to evaluate the effects of this supplement under conditions of increased fatigue and with longer supplementation periods.

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## EFFECT OF ROTARY INERTIA DEVICES ON SPRINT CURVE PERFORMANCE IN SEMI-PROFESSIONAL FEMALE SOCCER PLAYERS

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**Introduction:** Rotary inertia device (RID) resistance training is shown effective in improving sprinting and unilateral deficit performance in male soccer players (1,2), however, this is not clear in female soccer players. We aimed to assess the effect of RID on this physical abilities in female soccer players. **Methods:** Thirty-two semi-professional soccer players were divided into an experimental group [EG ( $n = 16$ ); mean  $\pm$  SD:  $21.24 \pm 2.57$  years] and in a control group [CG ( $n = 16$ ); mean  $\pm$  SD:  $24.21 \pm 5.69$  years]. All the players participated in 3 specific soccer training sessions per week lasting an hour and a half, to which was added the weekly match league competition. The EG performed 2 training sessions per week with rotary inertia devices (2 sets of 6 repetitions with each leg consisted of frontal and lateral resisted movements), while the CG did not perform any additional resistance training program during the 8 weeks that the work lasted. Time in the curve sprint to the right (mid test: SCMd and end of test: SCFd) and curve sprint to the left (mid test: SCMi and end of test: SCFi) were assessed. Time difference between half curve sprint to the right and to the left (SCMd-SCMi) and time difference between the final curve sprint to the right and to the left (SCFd-SCFi) were calculated. **Results:** There was a significant reduction on the SCMi performance in the EG respects to the CG (5.53%; SE = 0.372). Its performance increases with signs of significance in SCMd  $p =$

0.08; SE = 0.384) as well as there was a significant reduction in the unilateral SCMd-SCMi deficit in the EG respected to the CG ( $p$ -value = 0.015; SE = 0.375). **Conclusion:** The use of this type of exercises carried out with rotary inertia resistance have achieved the balance of the unilateral deficit in a task of progressive curve COD during 8 weeks of training in a group of semi-professional female soccer players.

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## BODY COMPOSITION AND CARDIOVASCULAR FITNESS BY SEX ACCORDING TO BONE MINERAL DENSITY LEVEL: A TWO-STEP CLUSTER ANALYSIS

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**Introduction:** Muscle contraction is the main source of mechanical loading leading to bone adaptations as bone and muscle are mechanically, biochemically, and molecularly coupled (1). However, bone health may also be influenced by aging, body composition, or sex (2). Therefore, the objectives of this work were: (i) to identify the main bone mineral density (BMD) clusters based on BMD of body regions, and ii) to compare body composition, cardiovascular fitness and age between these groups. **Methods:** Body composition and BMD were analysed by dual-energy X-ray absorptiometry (GE Lunar Prodigy) and cardiovascular fitness by a gas analyzer (JAEGER® Vyntus CPX) in 189 males (age:  $42.7 \pm 12.5$  years; mass:  $75.5 \pm 9.1$  kg; height:  $175.8$  cm;  $VO_{2max}$ :  $48.6 \pm 9$  ml·kg<sup>-1</sup>·min<sup>-1</sup>) and 143 females (age:  $33.7 \pm 12.1$  years; mass:  $59.5 \pm 8.6$  kg; height:  $163.5 \pm 5.8$  cm;

$\text{VO}_2\text{max}$ :  $39 \pm 17.3 \text{ ml} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$ ). A 2-step cluster was conducted to determine the number of clusters using the Bayesian Information Criterion (BIC). One-way ANOVA, independent T-test, and non-parametric tests were used to compare previously determined cluster characteristics among males and females, respectively. **Results:** Three clusters were determined for males and 2 for females. Main effect for males (higher, medium and lower, respectively) was observed in fat mass ( $15.5 \pm 8.5$  vs.  $14.5 \pm 6.8$  vs.  $11.6 \pm 5.9$  kg;  $p = 0.034$ ), fat-free mass ( $62.6 \pm 5.8$  vs.  $58.5 \pm 5.1$  vs.  $55.2 \pm 6.1$  kg;  $p < 0.001$ ) and  $\text{VO}_2\text{max}$  ( $3849.5 \pm 655.3$  vs.  $3653 \pm 600.3$  vs.  $3346.8 \pm 645 \text{ ml} \cdot \text{min}^{-1}$ ;  $p < 0.001$ ), but not in age. Significant differences in females (higher and lower, respectively) were observed in age ( $31.3 \pm 11.7$  vs.  $37.3 \pm 12$  years;  $p = 0.004$ ), fat mass ( $16.7 \pm 6.8$  vs.  $13.6 \pm 4.9$  kg;  $p = 0.008$ ), fat-free mass ( $44.6 \pm 5$  vs.  $40.7 \pm 2.9$  kg;  $p < 0.001$ ) and  $\text{VO}_2\text{max}$  ( $2785.9 \pm 518$  vs.  $2491.3 \pm 395 \text{ ml} \cdot \text{min}^{-1}$ ;  $p < 0.001$ ). **Discussion:** This study reinforces the important role of lean mass in BMD, as previously suggested (1). Furthermore, it seems that there may be factors associated with fat mass that may have a positive effect on bone health. However, it is unknown if this is weight-independent or if it only contributes to increased mechanical stress due to increased loading, as previous studies suggest that excessive fat mass can have detrimental effects on bone health (3). On the other hand, age seems to influence BMD in females, which could be related to the sudden drop in sex hormone concentrations and BMD after menopause, in contrast to men who have a steady decrease in testosterone and BMD (2).

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## DIFFERENCES IN THE VENTILATORY THRESHOLD POSITIONS RELATIVE TO $\text{VO}_2\text{MAX}$ ACCORDING TO $\text{VO}_2$ AT EACH THRESHOLD

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**Introduction:** Zapico's study observed that ventilatory threshold 1 (VT1) and 2 (VT2) increased in percentage of  $\text{VO}_2\text{max}$  during a season (1). On the contrary, Iannetta's study (2) suggested the percentage of  $\text{VO}_2\text{max}$  at which lactate threshold and maximal lactate steady state occurs (i.e., reflection of VT1 and VT2 when measuring lactate) are similar in individuals with different fitness level. Based on these apparently contradictory results the aim of the present work was to observe whether training status affects VT1 and VT2 position relative to  $\text{VO}_2\text{max}$ . **Methods:** The sample size consisted of 971 males and 301 females. They performed a ramp-incremental test on a treadmill which typically consisted of 3-minute warm-up between 4–6  $\text{km} \cdot \text{h}^{-1}$  followed by an incremental phase increasing 1  $\text{km} \cdot \text{h}^{-1} \text{ min}^{-1}$ . Breath by breath oxygen consumption ( $\text{VO}_2$ ) was analyzed with a Jaeger Oxycon-Pro (Erich Jaeger, Germany) or JAEGER®-Vyntus-CPX (Jaeger-CareFusion, Germany). VT1 and VT2 were determined as previously described (3). Subjects were subsequently classified in terciles (high, medium and low) considering the relative  $\text{VO}_2$  at VT1 and VT2 separately (one classification per threshold). **Results:** Males with a higher  $\text{VO}_2$  at VT1 had a greater VT1 position relative to  $\text{VO}_2\text{max}$  (high:  $68.3 \pm 5.5\%$ ; medium:  $65.2 \pm 5.5\%$ ; low:  $59.9 \pm 8\%$ ;  $p < 0.001$ ). The same occurred for VT2 (high:  $91.1 \pm 4.2\%$ ; medium:  $89 \pm 4.8\%$ ; low:  $85.4 \pm 7.3$ ;  $p < 0.001$ ). Females with a higher training status at VT1 had a greater VT1 position relative to  $\text{VO}_2\text{max}$  (high:  $70.8 \pm 5.7\%$ ; medium:  $67.1 \pm 4.3\%$ ; low:  $61.1 \pm 8\%$ ;  $p < 0.001$ ). The same was true for VT2 (high:  $86.4 \pm 7.6\%$ ; medium:  $90.6 \pm 4.8\%$ ; low:  $86.4 \pm 7.6$ ;  $p < 0.003$ ). **Discussion:** Our results are in line with Zapico et al. (1). However, they are not aligned with Iannetta et al. (2), who suggested the percentage of  $\text{VO}_2\text{max}$  at which lactate threshold and maximal lactate steady state occurs are not different in individuals with different fitness level. The main difference is that they classified subjects according to relative  $\text{VO}_2\text{max}$  and we classified subjects according to relative  $\text{VO}_2$  at VT1 and VT2. In conclusion,  $\text{VO}_2$  at VT1 and VT2 seems to influence on VT1 and VT2 positions relative to  $\text{VO}_2\text{max}$ , respectively, in females and males. Therefore, our results show that athletes may be in a different training zone even when they exercise at the same relative intensity determined from  $\text{VO}_2\text{max}$ .

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## ACUTE EFFECTS OF VOLUNTARY ISOMETRIC CONTRACTIONS AT MAXIMAL SHORTENING ON FLEXIBILITY, STRENGTH, AND JUMP PERFORMANCE

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**Introduction:** It is known that in contractions where the muscle is shortened, strength gains are especially due to neural adaptations (1). In these positions, the effectiveness of the movement depends on the muscle spindles being able to send information to the central nervous system by stretching intrafusal fibers via gamma motor neurons (2). Tests have been used to detect neuroproprioceptive vulnerability based on the assessment of strength in positions of maximum muscle shortening (3). The aim of this study was to analyze the acute response regarding flexibility, strength and jump height after Voluntary Isometric Contraction at Maximal Shortening (VICAMS) vs Ballistic Stretching (BS) of the same joint movement. **Methods:** A total of 60 healthy, physically active subjects were randomly distributed into 3 groups and given different interventions: VICAMS; BS; no intervention to a control group (CG). VICAMS group performed 1 set of 9 repetitions of 5 seconds per leg of isometric contraction in flexion, extension, abduction, adduction of the hips and flexion, extension of the knees. On the other hand, BS achieved 3 sets of 20 seconds per leg to work. Active range of motion (AROM), maximal voluntary isometric force (MVIF) and countermovement jumping (CMJ) were measured pre and post the intervention as performance measure to each protocol. The CG was re-measured 20 minutes after the pretest. **Results:** ANOVA test has been used to see the difference between groups finding significant differences ( $p < 0.01$ ) between the VICAMS group versus the others in hip and knee extension. CMJ and MVIF in right and left hip were measured before and after the intervention. Improvements were made based on premeasures only in the VICAMS group. **Discussion:** In conclusion, we can state that use VICAMS in the warm up has proven to be an effective system for improving flexibility, strength and jump height, due to acute effects have been significantly better than BS. The application of

VICAMS can be useful for trainers due to its speed, effectiveness, low cost and small space required for its application.

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## ANALYSIS OF MOVEMENT VARIABILITY TO QUANTIFY FATIGUE AFTER HIGH-INTENSITY FUNCTIONAL TRAINING VS TRADITIONAL STRENGTH TRAINING

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**Introduction:** Neuromuscular fatigue is a process induced by exercise that results in a decrease in the body's capacity to generate force. Excessive fatigue can lead to a loss of performance and/or an increased risk of injury (1). Analysis of force variability has been proposed as a tool to describe fatigue or to know effects of increasing difficulty in standing balance tasks (2). High-Intensity Functional Training have shown responses of fatigue such RPE, accumulated lactate and muscle damage higher than traditional strength training (3). This study aimed to analyse movement variability after traditional strength training (ST) and High-Intensity Functional Training (HIFT) to verify if this marker can be used for fatigue monitoring. **Methods:** Ten subjects were enrolled for 2 weeks, and they would perform ST and HIFT. Pre- and post-training subjects performed 30 seconds of single leg stance; in addition, these measures were repeated 24 and 48 hours after training. The signals were analysed with an accelerometer (ISEN) using Detrended Fluctuation Analysis (DFA), Entropy Fuzzy (FuzzyEn) and Standard Deviation (SD). Differences among training methods and time points (pre; post; ret1; ret2) were analysed with repeated measures ANOVA. Statistically significant was set at  $p < 0.05$ . **Results:** Between types of training only a significant effect was found in ret2 for the SD of unilateral balance on the right leg ( $p = 0.034$ ) returning to initial deviation in ST but no in HIFT. Nevertheless, inside groups significant differences were

found in time points in the DFA in the right leg between post-ret1 ( $p = 0.036$ ), and in the DFA in the left leg between post-ret1 ( $p = 0.023$ ). As well differences were founded in left and right leg in the FuzzyEn ( $p = 0.030$ ;  $p = 0.20$ ). **Discussion:** Analysis of movement variability could be a useful tool to detect fatigue process after ST or HIFT, however only the traditional measure *SD* of the signal could detect differences between methods after 48 hours post-training.

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## INFLUENCE OF INTER-REPETITION REST IN THE RELATIONSHIP BETWEEN MAXIMUM REPETITIONS TO FAILURE AND LIFTING VELOCITY

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**Introduction:** The maximum number of repetitions performed to failure (RTF) and the fastest mean velocity (MVfastest) relationships in a set have been proposed for the prescription of the loads associated with a specific RTF to decide how many repetitions to perform in each training set (1). This study compared the goodness-of-fit of the relationships between the RTF-MVfastest, under different inter-repetition rest (IRR) configurations (zero seconds [IRR0], 3 seconds [IRR3], and self-selected interval less than 5 seconds [SSIRR]) during the free-weight back squat and bench press exercises. Additionally, the influence of IRR on the MVfastest associated with different RTFs has been examined. **Methods:** Eighteen male students completed one session per IRR configuration, consisting of 3 single sets of repetitions to failure (65–75–85% of the one-repetition maximum) during the free-weight back squat and bench press exercises. The relative loads were estimated in

each session through the load-velocity relationship. The generalized RTF-MVfastest relationships were obtained by pooling together the data from all subjects, whereas the individualized RTF-MVfastest relationships were determined specifically for each subject. **Results:** Individualized RTF-MVfastest were stronger than generalized (median R2 = 0.98 vs. 0.65 and SEE = 1.2 vs 3.7 repetitions). The goodness-of-fit of the relationships was stronger for SSIRR than IRR0 during the back squat ( $p \leq 0.004$ ) and comparable between IRRs during the bench press ( $p \geq 0.279$ ). During the back squat, MVfastest values were higher for IRR0 than IRR3 and SSIRR (8th–15th RTF;  $p \leq 0.065$ ), while during the bench press, they were higher for IRR0 than for IRR3 (11th–15th RTF;  $p \geq 0.279$ ). **Discussion:** These results highlight the importance of standardizing the IRR during sets to failure used to establish RTF-MVfastest profiles. From a practical perspective, an SSIRR could be recommended as a more ecologically valid (i.e., subjects adopt a brief IRR based on their needs), accurate (i.e., higher goodness of fit of RTF-MVfastest) and objective procedure (i.e., steeper RTF-MVfastest due to higher RTF and velocity maintenance in the set) in free weight back squat and bench press exercises.

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## INDIRECT MARKERS TO DETERMINE MUSCLE FATIGUE RECOVERY IN WOMEN AND MEN

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**Introduction:** During sprinting, repeated high intensity eccentric contractions can result in hamstring muscle strain and potentially, loss of muscle function (1). Although there are several indirect markers of muscle damage, the loss of force-generating capacity (FGC) is highly correlated with muscle fiber ultrastructural alterations (2). Therefore, the purpose of the study was to determine

muscle recovery using FGC in men and women, and to explore its relationship with other indirect markers of muscle low frequency fatigue. **Methods:** Healthy females [ $n = 14$ , age =  $22.2 \pm 3.1$  years (mean  $\pm$  SD)] and males [ $n = 15$ , age =  $22.5 \pm 3.2$  years (mean  $\pm$  SD)] completed 10 sets of 40-meter sprints, resting for 3 minutes between sets. Isometric FGC, range of motion (ROM), perceived soreness (PS), jumping performance and sprint mechanical properties were tested at baseline and 24-, 48- and 72-hours post-exercise. According to FGC loss during recovery period, subjects were classified into high responders (HR) and low responders (LR) in accordance with the criteria of Paulsen et al. (3). **Results:** Both HR males and females showed unrecovered FGC during the 72-hour recovery period [F (3,81) = 4.576,  $p = 0.005$ ]. Similarly, HR individuals reported significant decreases in ROM at +24 hours [MD = 11.0% (2.8 to 19.3%),  $p = 0.005$ ], +48 hours (MD = 9.6% (3.6 to 15.4%),  $p < 0.001$ ) and +72 hours (MD = 14.3% (3.9 to 24.7%),  $p = 0.004$ ) and increases of PS at +24 hours [MD = 1.4 AU (0.5 to 2.3 AU),  $p = 0.003$ ], +48 hours (MD = 1.9 AU (0.8 to 3.1 AU),  $p < 0.001$ ) and +72 hours (MD = 1.2 AU (0.3 to 2.0 AU),  $p = 0.006$ ). However, there were no differences between groups in relation to sprint mechanical properties (time to 40 m, V0 and F0). Finally, HR and LR individuals presented no decrease in jumping performance. **Conclusion:** The findings support that both isometric FGC and ROM are powerful indirect tests for monitoring muscle recovery, in a cost-effective way. There is, however, a high inter-individual variability in sprint mechanical properties. Finally, jumping performance is not related to muscle recovery after repeated sprint training.

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## CRITERION VALIDITY AND RELIABILITY OF A LOW-COST HANDGRIP DYNAMOMETER: THE CAMRY DYNAMOMETER

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**Introduction:** Handgrip strength has been related with multiple health outcomes, including all-cause mortality and morbidity (1). Handgrip testing is a highly valid and reliable method, included in evidence-based fitness test batteries for different age groups (2,3). Previously, Jamar and TKK dynamometers

have shown a good reliability and validity against known-weights (4,5). However, the economic cost of these dynamometers might be a limitation, particularly for its use at large scale. Recently, a cheaper (10% of the price) version (Camry Dynamometer) has been used in fitness surveillance systems (such as Hungary or Slovenia), though its reliability and validity, compared to known weights and other well-validated dynamometers, remains unknown. Therefore, the aims of the current study were to test the criterion-related validity of Camry dynamometer, using calibrated known weights, to examine test-retest reliability, intermodel reliability (comparing a Camry dynamometer with over 1000 uses versus a new Camry dynamometer), and interinstrument reliability (Camry dynamometer versus TKK dynamometer). **Methods:** A digital TKK dynamometer (range measurement: 5–100 kg) and 2 Camry dynamometers (range measurement: 1–90 kg) were used. For the verification of the weights, we used a high precision SECA scale (Model 769; SECA, Hamburg, Germany). Dynamometers were placed between 2 stable bases, and weights were suspended from the dynamometer with a loading belt. Dynamometers and the weights were tested in a randomized order. Intra-instrument and interinstrument reliability, and criterion related validity were assessed using Bland and Altman's method. **Results:** According to the intra-instrument test-retest reliability, New Camry dynamometer had the smallest mean error ( $0.01 \pm 0.49$  kg), followed by its old version ( $-0.10 \pm 0.49$  kg) and TKK dynamometer ( $0.14 \pm 0.77$  kg). When comparing between instruments, the mean differences between the 2 Camry dynamometers resulted smaller ( $0.03 \pm 0.57$  kg) than the differences between Camry dynamometers and TKK (New Camry vs. TKK:  $0.84 \pm 0.79$  kg; Old Camry vs. TKK:  $0.88 \pm 0.85$  kg). Criterion related validity showed a small-magnitude negative systematic error in the 3 instruments (New Camry:  $-0.21 \pm 0.35$  kg; Old Camry:  $-0.18 \pm 0.79$  kg; TKK:  $-1.07 \pm 0.75$  kg). **Discussion:** The 3 instruments showed good test-retest reliability (all systematic error  $\leq 0.14$  kg). All dynamometers showed an acceptable error compared to known weights, yet the Camry dynamometers showed higher criterion-related validity than Digital TKK dynamometer. Our results support that Camry dynamometer has solid reliability and validity and can be therefore used for handgrip strength assessment.

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## RELATIONSHIP BETWEEN MAXIMUM NUMBER OF REPETITIONS AND LIFTING VELOCITY

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**Introduction:** This study aimed to explore the goodness-of-fit and accuracy of generalized and individualized relationships between the maximum number of repetitions performed to failure (RTF) and the fastest mean velocity of the set (MVfastest) in both the free-weight and Smith machine bench press exercises.

**Methods:** Twenty-eight (16 men and 12 women) individuals completed one familiarization session followed by 4 experimental sessions (2 using free-weight and 2 using Smith machine). These experimental sessions were identical, involving 3 single sets of repetitions to momentary failure against the 65%, 75%, and 85% of the one-repetition maximum, interspersed by 10-minute of rest. **Results:** Individualized RTF-MVfastest relationships were always stronger than generalized RTF-MVfastest relationships ( $R^2$  range: 0.73–1.00 vs. 0.33–0.69). The goodness-of-fit between both exercise modes and sexes was comparable ( $p \geq 0.510$ ). There were not significant differences in the estimated MVfastest values between exercise modes ( $p \geq 0.258$ ), while the MVfastest associated with RTF from 6 to 15 was higher for men than for women ( $p \leq 0.043$ ;  $ES \geq 0.69$ ). The precision (absolute errors) in estimating the RTF during the second experimental session, using RTF-MVfastest equations from the first session, was comparable between exercise modes and loads ( $p < 0.076$ ), but higher for men (<2 RTF) than for women ( $\geq 2$  RTF) ( $p \leq 0.018$ ;  $ES \geq 0.58$ ). **Conclusions:** These findings suggest using individualized RTF-MVfastest to accurately estimate the RTF associated with a specific velocity in recreationally trained men during both free-weight and Smith machine bench press exercises, but not with women.

## ENHANCING CARDIOVASCULAR HEALTH ASSESSMENT: A COMPREHENSIVE HANDGRIP STRENGTH DYNAMOMETRY REFERENCE FOR SPANISH CHILDREN AND ADOLESCENTS

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**Background:** Handgrip Strength Dynamometry (HSD) has emerged as a valuable indicator of health, particularly in relation to Body Mass Index (BMI) and body composition, offering insights into cardiovascular health in children and adolescents. However, up-to-date reference values for HSD percentiles in this demographic are scarce. Robust studies with large sample sizes are essential to provide accurate and reliable reference data. In Spain, the PESCA program initiated yearly HSD measurements for children in 2018. This study seeks to expand and enhance the existing reference table for HSD percentiles by incorporating data from 2 other comprehensive studies: PASOS, and ASOMAD, encompassing a combined total of 3400 subjects.

**Methods:** The PESCA program utilizes a 5-step protocol encompassing a questionnaire, BMI assessment, body composition bioimpedance analysis (BIA), Handgrip Strength Dynamometry (HSD), and a physician-conducted physical examination. This PESCA analysis is based on data collected from 1772 children and adolescents. Additionally, 851 subjects from the ASOMAD study and 777 subjects from the PASOS study were included. HSD measurements were obtained using a Takei dynamometer (0–100 kg). Two measurements, taken 60 seconds apart, involved the child standing with the dominant arm extended parallel to the trunk, exerting maximal force for 10 seconds. The highest recorded measurement was retained for analysis. Data were processed using SPSS 25v, with stratification by age and sex. Descriptive statistics, including averages, standard deviations, and percentiles, were calculated for each age group from 3 to 16 years. **Results:** Of the total sample of 3400 subjects (48,5 % girls), 33 individuals were excluded due to incomplete handgrip technique or data recording issues. Data from children aged 2, as well as girls and boys aged over 17, were not included in percentile calculations due to insufficient group sizes. The revised HSD percentile curves for boys and girls will be presented, reflecting the amalgamation of data from the PESCA, PASOS, and ASOMAD studies. **Conclusion:** This study provides a comprehensive and up-to-date reference for HSD percentiles in Spanish children and adolescents. The incorporation of data from the PESCA, PASOS, and ASOMAD studies, with a total of 3400 subjects, ensures the robustness and reliability of these reference values. Moreover, these HSD percentiles offer a powerful tool for both screening and monitoring

cardiovascular health. By establishing normative values, health-care professionals can better assess cardiovascular risk factors and track changes in muscle strength over time, ultimately contributing to more effective preventive strategies and improved cardiovascular outcomes in children and adolescents.

## INFLUENCE OF THE MENSTRUAL CYCLE ON NEUROMUSCULAR PERFORMANCE IN PROFESSIONAL HANDBALL PLAYERS

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**Introduction:** Despite limited evidence regarding the influence of the menstrual cycle (MC) on performance, there is a widespread belief in the negative impact of the hormonal changes associated with the MC on female athletes' physical performance (1). Thus, this study aimed to assess changes in neuromuscular and sport-specific skills performance during a complete MC in professional handball players. **Methods:** Sixteen professional female handball players ( $21.7 \pm 3.2$  years) voluntarily participated in this study. Neuromuscular and sport-specific skills were tested each 48 hours during a complete MC (14 average testing sessions in total). During each testing session, kinetic and kinematic variables of the countermovement jump (CMJ) and the drop jump (DJ), peak force and rate of force development (RFD) of the mid-thigh pull test (MTP), and overhead throwing velocity were measured. **Results:** Significant differences were found in the time taken for takeoff during CMJ, with the 20–23 days of the MC showing longer times compared to the other measurements. Additionally, differences were observed in the relative strength index (RSI) during the DJ, showing significant lower values on day 6 and 8 compared to the 13th measurement. However, no significant differences were observed on jump height, peak propulsive force, propulsive phase power, peak landing force, propulsive impulse and mRSI during the CMJ and DJ between the different testing days of a complete MC. Regarding peak force and RFD during the MTP and peak throwing velocity, no differences were found between measurements. **Discussion:** In conclusion, no fluctuation in vertical jump performance, isometric strength, and throwing velocity was observed over a complete MC in professional handball players. The only variables that were slightly affected in specific measurements were the time taken for takeoff in the CMJ and the RSI in the DJ. Therefore, these results demonstrate that contrary to theoretical models positing an increase in performance during the late luteal and

ovulation phase, and a decrease during the follicular and menstrual phases, neuromuscular performance and handball-specific explosive actions such as throwing velocity remain unaffected by the hormonal changes associated with the MC. However, our findings open the door to future research on explosive strength, as it is one of the most important skills in handball and can contribute to injury prevention.

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## DFA1 0.75 AS A BIOMARKER OF THE FIRST VENTILATORY THRESHOLD? SOMETHING CHANGES IN OLDER WOMEN

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**Introduction:** Aligned with the first ventilatory threshold (VT1), the so-called Heart Rate Variability Threshold Low (HRVTL) reflects parasympathetic stabilization in response to increasing intensity in a cardiopulmonary exercise test (CPET) [1]. More specifically, the short exponent of the detrended fluctuation analysis (DFA1) at 0.75ua confirms promising as an inexpensive non-invasive biomarker of these moderate-to-heavy intensity boundaries [2,3]. Since this evidence is limited to men, this study analyses DFA1 along a cycling CPET in active women over-60, once after VT1 and VT2 detection. Whether DFA1\_0.75 matches muscle power (w) at VT1 will give light to their autonomic/cardiometabolic responses. **Methods:** Seventeen normotensive active women ( $65.88 \pm 6.46$  years) completed a submaximal cycling CPET, previously detailed [4] (10 W  $\times$  3 minutes 15 seconds stages). Lowest EqO2 (VE/VO2) and ExCO2/VO2 for VT1; together with lowest LnEqCO2 (VE/VCO2) and RER/VO2 increase for VT2, were calculated. HRV was registered continuously by means of the Polar-H10 band and the Sensor-Polar-Logger App, for further DFA1 calculations with Kubios-HRV-scientific software [3]. The last 2 minutes in each stage were considered [5], retaining DFA1 at VT1 (HRVTL), VT2, and at the end of the test (P100). **Results:** DFA1 decreased from HRVpre-test, sitting, to HRVTL [1.17ua (1.02–1.31) to 0.99ua (0.82–1.15)], at the power of 41.88w (35.07–48.67) in VT1. Conversely to expected, DFA\_0.75 appeared at VT2 [0.75ua (0.55–0.95)], and lost complexity only at P100 [0.56ua (0.41–0.71)]. Average powers where, then, 68.13 w (59.60–76.66) and 82.50w

(75.35–89.65) respectively. RER [0.90ua (0.87–0.93)], RPE\_1-10\_scale [0.81ua (0.33–1.30)], VAS\_1-10\_scale [0.44ua (0.00–0.99)], and VO<sub>2</sub> [12.66 ml·kg<sup>-1</sup> × min<sup>-1</sup> (10.28–15.04)], completed the information at VT1, which was located at the 72.39% (61.09–83.69) of VO<sub>2</sub>peak [17.36 ml·kg<sup>-1</sup> × min<sup>-1</sup> (13.42–21.30)]. Noteworthy, HRVTL differed significantly ( $p < 0.05$ ) from DFA1\_pre-test, DFA\_VT2 and DFA\_P100. **Discussion:** The concept DFA\_0.75 = HRVTL failed, despite DFA1 mirrored the vagal withdrawal, and HRVTL confirmed its capacity to differentiate moderate-to-heavy exercise intensities [2,3]. A severe reduction in muscle power and anticipated glucose dependence in older women [4], confirmed by our data and RER > 0.85ua in VT1, might reflect a very small, almost inexistent lipolytic zone, and thus the start of complexity reduction displaced to VT2. Effort duration and intensity might be, then, enough demanding (i.e., higher cardiac autonomic coordination and ATP needs).

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## EFFECTS OF COMBINED TREATMENT WITH TRANSCRANIAL AND PERIPHERAL ELECTROMAGNETIC STIMULATION ON PERFORMANCE AND PAIN RECOVERY FROM DELAYED ONSET MUSCLE SORENESS INDUCED BY ECCENTRIC EXERCISE IN YOUNG ATHLETES: A RANDOMIZED CONTROL TRIAL

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**Introduction:** There is a common interest in finding a common consensus in the approach of athletes suffering from DOMS with the aim of improving symptoms and thereby enhancing performance. Additionally, the incorporation by the trainers of eccentric exercises into training is known for its clinical benefits and improved physiological adaptations. The objective of this

study was to observe the effects of a paired-associative transcranial and peripheral electromagnetic stimulation on young athletes suffering from DOMS, induced by 1 hour of eccentric and plyometric exercises. **Methods:** Forty-eight young athletes participated in this randomized control trial: 13 were assigned to the peripheral group (SP); 12 were in the control group (PL); 11 were assigned to the transcranial group (TS) and 12 were included in the paired-associative group (AS). The Visual Analogue Scale of pain perception, the mechanical pressure pain threshold were the tools used to analyze the symptoms of DOMS. On the other hand, the Half Squat test evaluated with an accelerometer, and 30 meters sprint velocity were used to observe the evolution of the sports performance of the lower limbs. All evaluations were performed before and after the eccentric exercise session that caused DOMS, as well as at 24-48, and 72 hours afterward. **Results:** The treatment session with the paired-associative electromagnetic stimulation did improve the symptoms of the induced DOMS, since significant differences were observed. Based on the results a treatment with both peripheral and transcranial electromagnetic stimulation improves recovery and performance in athletes at 72 hours, although these data would need to be verified in future research with a larger sample size. **Conclusions:** Paired-associative electromagnetic stimulation slightly improve DOMS symptomatology, velocity, and sports performance in the lower limbs.

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## CALF MUSCLE INJURIES IN SOCCER PLAYERS: WHAT ARE THE STRENGTH-RELATED RETURN TO PLAY CRITERIA? A SYSTEMATIC REVIEW

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**Introduction:** Total injuries in soccer have significantly decreased in recent seasons, although muscle injuries

incidence has not decreased [1]. Calf muscle injuries are among the 4 most prevalent muscle injuries in soccer, with a mean time-loss only surpassed by quadriceps injuries [2]. In addition, re-injuries of these index calf injuries present a higher time-loss [2]. In this line, it is important to establish return to play criteria for a safe return to sport [3]. **Methods:** The present review is one of a 4-part systematic review project. Five databases were searched. 51140 studies were screened. Studies that included soccer players with a calf injury and established return to play criteria were included. **Results:** Eighteen studies were included. Strength-related return to play criteria were: 1) Symmetry and pre-injury score (i.e., > 30 repetitions) in calf raise test; 2) Symmetry and pre-injury score in vertical and horizontal hopping; 3) Symmetry and pre-injury levels on dynamometric tests; 4) Symmetry and pre-injury levels on drop jump test; 5) Pre-test differences in Barrow and shuttle 8 x 5 m test lower than 10%; 6) Symmetry in concentric and eccentric countermovement jump kinematics variables (i.e., impulse 100 ms, peak force, force at zero velocity, eccentric deceleration RFD, eccentric peak force and eccentric:concentric ratio). Several return to play criteria about pain, external load parameters or range of motion should be considered. **Discussion:** Regarding strength evaluation after a calf muscle injury in a soccer player, strength and conditioning coaches should assess the calf raise test, vertical and horizontal hoppings, analytical dynamometry plantar flexors isometric tests, agility tests and countermovement jumps kinematics for a safe return to play. **Acknowledgements:** The authors would like to thank Gregory D Myer and Nicol Van Dyk for their collaboration in the study.

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## IMMERSIVE VIRTUAL REALITY: IMPACT ON QUALITY OF LIFE IN INDIVIDUALS WITH PHYSICAL DISABILITIES

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**Introduction:** Immersive Virtual Reality (IVR) can offer better outcomes in certain exercises compared to conventional rehabilitation. In 2020, the use of IVR was compared to conventional rehabilitation in individuals with Parkinsons disease (1), and the latest systematic review on IVR and physical activity related to therapy (2) noted that most subjects were stroke patients. The objective of this research was to determine if there was a significant improvement in quality of life (QoL) and functionality level after an IVR protocol in individuals with disabilities. **Methods:** This was a quasi-experimental study involving 44 subjects with physical disabilities from the Puente Centers of the Fundació Isidre Esteve. The study followed the Declaration of Helsinki, and subjects provided informed consent before being randomly divided into a control group (CG) and an experimental group (EG). All subjects underwent a QoL test (GENCAT) and various functionality tests, which varied depending on whether they used a wheelchair. For wheelchair users, an upper limb functionality test (DASH) and a central stability test (MFRT) were administered, while those who could walk underwent a functionality test (TGUGT), the Berg scale to measure the risk of falling, and a central stability test (FRT). The EG carried out an IVR protocol 3 times a week for ten weeks. Each session, lasting ten minutes, included 2 different activities with a physical component, ranging from fine motor skills to high-level sports activities. **Results:** The EG improved their QoL test score by 9% ( $p = 0.001$ ); 6% ( $p = 0.024$ ) and 14% ( $p = 0.002$ ) in functionality tests for individuals who did not require a wheelchair, and 13% ( $p = 0.015$ ) in the central stability test for wheelchair-dependent individuals. **Discussion:** The results align with the existing literature (1), as a positive outcome was observed in individuals with reduced mobility due to stroke or sclerosis who were not wheelchair-dependent. Following the latest reviews (3), IVR is considered a tool for post-stroke rehabilitation, improving QoL and functional aspects, as well as having a moderate effect on depression (4).

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