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ASUNTO

BENITEZ FLORES, STEFANO - SOLICITUD DE INGRESO AL RÉGIMEN DE DEDICACIÓN TOTAL - RDT - CARGO 556184 - ASISTENTE -INTERINO- (ESC. G001; G°2; 20) DE DEPARTAMENTO DE EDUCACIÓN FÍSICA Y SALUD - FUNDAMENTOS BIOLÓGICOS

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Tipo	DEDICACION TOTAL - SOLICITUD DE

Funcionario/s:

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38916289	Benitez Flores, Stefano		556184	G001	2	20

Categoría:	Docente
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	Expediente Nro. 008440-000023-24 **Actuación 1**	Oficina: SECCIÓN PERSONAL - CENTRO MONTEVIDEO - ISEF Fecha Recibido: 06/02/2024 Estado: Cursado

TEXTO

Sección Personal eleva solicitud, dejando constancia que la documentación adjunta se recibió desde stefanobenitez@gmail.com

Asimismo es importante mencionar que el cargo que desempeña el docente BENITEZ es de carácter interino con vencimiento al 31/03/24

Se adjunta Carrera Funcional

Pase a Comisión de Dedicación Total -ISEF a consideración e informe. Cumplido siga a UGP para informe de disponibilidad

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Nombre Anexo	Tamaño	Fecha
publicaciones.pdf	2649 KB	06/02/2024 13:13:58
CV y cartas.pdf	903 KB	06/02/2024 13:13:59
Benítez Flores Stefano Plan de actividades.pdf	196 KB	06/02/2024 13:13:59
Benítez Flores Stefano Formulario.pdf	18 KB	06/02/2024 13:13:59
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ORIGINAL ARTICLE

Combined effects of very short "all out" efforts during sprint and resistance training on physical and physiological adaptations after 2 weeks of training

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Abstract

Purpose The aim of this study was to compare the combined effects of resistance and sprint training, with very short efforts (5 s), on aerobic and anaerobic performances, and cardiometabolic health-related parameters in young healthy adults.

Methods Thirty young physically active individuals were randomly allocated into four groups: resistance training (RTG), sprint interval training (SITG), concurrent training (CTG), and control (CONG). Participants trained 3 days/week for 2 weeks in the high-intensity interventions that consisted of 6–12 "all out" efforts of 5 s separated by 24 s of recovery, totalizing ~ 13 min per session, with 48–72 h of recovery between sessions. Body composition, vertical jump, lower body strength, aerobic and anaerobic performances, heart rate variability (HRV), and redox status were evaluated before and after training. Total work (TW), rating of perceived exertion (CR-10 RPE) and mean HR (HR_{mean}) were monitored during sessions. Incidental physical activity (PA), dietary intake and perceived stress were also controlled.

Results Maximum oxygen consumption (VO_{2max}) significantly increased in SITG and CTG ($P < 0.05$). Lower body strength improved in RTG and CTG ($P < 0.05$), while countermovement jump (CMJ) was improved in RTG ($P = 0.04$) only. Redox status improved after all interventions ($P < 0.05$). No differences were found in TW, PA, dietary intake, and psychological stress between groups ($P > 0.05$).

Conclusions RT and SIT protocols with very short "all out" efforts, either performed in isolation, or combined, demonstrated improvement in several physical fitness- and health-related parameters. However, CT was the most efficient exercise intervention with improvement observed in the majority of the parameters.

Keywords High-intensity interval training · Sprint interval training · Concurrent training · Cardiometabolic health · Performance

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Abbreviations

α1	Detrended fluctuations of short-term fractal scaling
BPSS-10	Brazilian 10-item version of the perceived stress scale
CAT	Catalase
CMJ	Countermovement jump
CO_2	Carbon dioxide
CT	Concurrent training
CTG	Concurrent training group
CONG	Control group
CR-10	RPE Category-ratio 10 scale rating of perceived exertion
EE	Energy expenditure
GSH	Glutathione reduced
HIIT	High-intensity interval training

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HRV	Heart rate variability
IPAQ	International physical activity questionnaire
MF	Mean force
MP	Mean power
P_{max}	Maximum power
PP	Peak power
RER	Respiratory exchange ratio
RT	Resistance training
RTG	Resistance training group
RMSSD	Root mean square of successive differences between R–R intervals
RPM_{max}	Maximal pedaling rate
SDNN	Standard deviation of all R–R intervals
SIT	Sprint interval training
SITG	Sprint interval training group
SOD	Superoxide dismutase
TBARS	Thiobarbituric acid reactive substances
TW	Total work
UA	Uric acid
VE	Ventilation
VO_{2max}	Maximum oxygen consumption

Introduction

High-intensity interval training (HIIT) is defined as the repetition of high-intensity exercise bouts separated by short recovery periods of low-intensity exercise (Batacan et al. 2017). HIIT can be an optimal exercise strategy for improving cardiometabolic health, since even a short-time intervention was shown to increase maximum oxygen consumption (VO_{2max}), decreased body fat, blood pressure, and fasting glucose (Batacan et al. 2017). Sprint interval training (SIT) is a category of HIIT which involves supramaximal "all out" efforts, proving to be a great time-efficient strategy to generate several systemic and metabolic adaptations (Sloth et al. 2013). The most commonly used SIT model (4–6 sprints × 30 s) has been widely questioned due to its extreme physical and psychological demands (Biddle and Batterham 2015). Recently, SIT has been adapted to shorter sprints (≤ 20 s), demonstrating equally effective results (Vollaard and Metcalfe 2017). Therefore, it can be suggested that shortened sprint bouts could induce similar cardiometabolic adaptations associated with classical SIT (Gillen et al. 2016; Vollaard and Metcalfe 2017). In this context, some recent studies have shown that SIT of very short sprints (i.e. 5 s) induces a higher neuromuscular response and cardiorespiratory activity, while being less fatiguing and more tolerable (Islam et al. 2017; Townsend et al. 2017; Benitez-Flores et al. 2018). In addition, McKie et al. (2017) observed that 4 weeks of modified SIT (24–36 running efforts of 5 s) enhanced VO_{2max} similarly to a classical SIT. Further, Jabbour et al. (2018) revealed that a low training volume of very short bouts (6 s) was able to promote improvements in hemodynamic function after 18 training sessions. Furthermore, Tong et al. (2018) found that 12 week of this type of SIT reduced whole body and regional fat mass in obese young women. Therefore, it would be suggested that adapted SIT protocols of very short sprints are a promising strategy for improving both health and performance parameters without the commitments related to other traditional SIT interventions.

HIIT or SIT sessions can be combined with other training modalities, such as resistance training (RT), thus featuring a concurrent training (CT) model (Sabag et al. 2018). CT, defined as the simultaneous integration of resistance and endurance exercises into a periodized training regime (Fyfe et al. 2014), has emerged as an interesting option for physical conditioning and the prevention and treatment of a number of diseases (Chtara et al. 2008; Chudyk and Petrella 2011; Cadore et al. 2012; Fyfe et al. 2016; Robinson et al. 2017; Varela-Sanz et al. 2017). Previous studies have indicated that the gains in muscle strength may be compromised when resistance and endurance exercises are undertaken concurrently (Wilson et al. 2012; Coffey and Hawley 2017). In addition, Doma et al. (2017) have recently suggested that RT-induced fatigue may impair the quality of endurance training sessions thereby limiting optimization of endurance development. The physiological adaptations of CT depend on the specific physical stimuli, with intensity and volume being the two most important variables in mediating the interference effect (Wilson et al. 2012; Doma et al. 2017). Thus, overreaching or overtraining caused by traditional, high-volume, high-intensity or high-frequency endurance and/or resistance training have been proposed to elicit competing responses (Wilson et al. 2012; Doma et al. 2017). In this regard, modified SIT could be an interesting solution to minimize the interference effect. For instance, Cantrell et al. (2014) combined modified SIT (i.e. 20-s bouts) with resistance training (four to six repetitions with 85% of 1RM) and found similar improvement in upper and lower body maximum strength to the resistance training group after 12 weeks. Thus, it is reasonable to assume that the neuromuscular effects of very short efforts (i.e. 5 s) in a CT program could minimize the interference phenomenon, given that they provoke less metabolic disturbances and residual fatigue (Balsom et al. 1992a; Benitez-Flores et al. 2018). In addition, to the best of our knowledge, there are no data on the potential benefits of CT methods integrating shorter SIT for cardiometabolic health, as previous studies have mainly focused on neuromuscular adaptations (Cantrell et al. 2014; Laird et al. 2016). Such findings would improve our understanding of the benefit that SIT protocols may have on aerobic and anaerobic performance development, as well as cardiometabolic health-related parameters.

Thus, the aim of this study was to verify the effects of 2 weeks of RT, SIT and CT, using very short "all out" efforts of 5 s, on body composition, vertical jump capacity, lower body strength, aerobic and anaerobic performance, heart rate variability (HRV), and redox status. It was hypothesized that CT would provide the best results as training qualities from both modes of exercises (i.e. RT and SIT) would optimize several physiological-, physical- and health-related parameters.

Methods

Participants

Forty-one volunteers contacted the primary investigator after a publicity campaign between May and September of 2017 in the University Campus. From this sample, 33 individuals met the inclusion criteria and were subsequently enrolled in the study (16 males and 17 females). The inclusion criteria were: (1) being physically active according to the *International Physical Activity Questionnaire* (*IPAQ*); (2) not consuming any type of nutritional supplement or tobacco products; (3) to be free of risk factors associated with cardiometabolic diseases, and free of any musculoskeletal injury; (4) not having previously participated in HIIT programs; and (5) being between 18 and 35 years old. The participants were randomly allocated into four groups: RT group (RTG; $n=9$); SIT group (SITG; $n=9$); CT group (CTG; $n=9$); and control group (CONG; $n=6$). In addition, they were instructed not to consume foods that could interfere in their redox status, maintain their incidental lifestyle (work, hours of sleep, etc.) while avoiding other exercises during the experiment. Prior to participation, the experimental procedures and potential risks were fully explained to all participants in written and verbal forms. Thereafter, they were asked to sign the informed consent form. This study was approved by the Ethics Committee of Catholic University of Brasilia (protocol number CAAE 54813016.0.0000.0029) and was conducted in accordance with the principles stipulated in the Declaration of Helsinki.

Experimental design

This study adopted a randomized controlled design. Participants performed nine sessions during 3 weeks, including 1 day of familiarization, 2 days of testing before and after training, and six training sessions (Fig. 1). Each training session had 48–72 h of recovery. All the sessions were carried out at the same time of day (morning at 8–12 h or afternoon at 14–18 h), with constant environment conditions (temperature = 21–23 °C, relative humidity = 65–75%), and at an altitude of ~ 1200 m.

Informed consent and various questionnaires were completed at the beginning of the first session and, subsequently, body composition was evaluated. After that, familiarization with vertical jump, squat exercise, and cycle sprints was performed. On the second session, the tests were completed with the following sequence: (1) vertical jump; (2) isoinertial squat test; (3) incremental endurance test; and (4)

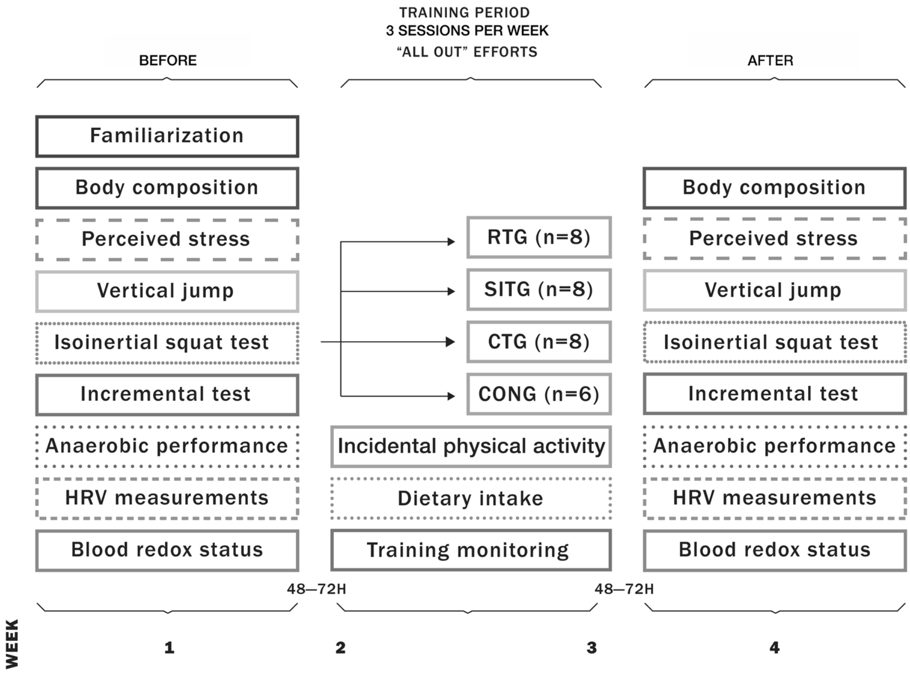

Fig. 1 HRV measurements and blood redox status were evaluated pre- and post-incremental tests. *RTG* resistance training group, *SITG* sprint interval training group, *CTG* concurrent training group, *CONG* control group

anaerobic performance. Blood samples and HRV measurements were collected pre- and post-incremental tests after 8 h of fasting, and without consuming alcohol or any product with caffeine 24 h before.

The training period included six sessions for all groups, with CTG combining both RT and SIT in the one session. Every session was composed of 6–12 efforts of 5 s at maximum effort with 24 s of recovery between bouts (Benitez-Flores et al. 2018), and with an exercise volume similar to previous studies that used modified SIT protocols (Hazell et al. 2010; Gillen et al. 2016; Jabbour et al. 2018). The researchers provided strong verbal encouragement for participants to achieve maximum effort in each session. Halfway through every training session, 3 min of rest was implemented to facilitate recovery (Balsom et al. 1992b). The training intensity was monitored in the 2nd, 3rd, 5th and 6th sessions by internal and external loading parameters. The incidental PA and dietary intake were recorded throughout the experiment. After the training period, the preliminary tests were repeated as described.

Body composition and familiarization

Participants arrived on the first day at the laboratory and completed informed consent, the *IPAQ* and the *Brazilian 10-item version of the perceived stress scale* (*BPSS-10*) (Reis et al. 2010). After that, body mass was measured with a digital balance (Toledo, Toledo2286PP, São Paulo, Brazil), stature with a stadiometer (Stadi-O-Meter, Novel Products Inc., Rockton, Illinois, USA), and body fatness was determined by DEXA (Lunar DPX-IQ, Wisconsin, USA). Subsequently, the adjustments in the cycle-ergometer (Model 828 E, Monark, Vansbro, Sweden) were completed according to the morphological characteristics of the subjects. The participants started a 2-min warm-up on a cycle-ergometer with 1kp at 50 rpm, which was followed by two maximal sprints of 5 s with 24 s of recovery and with 2kp of load. Immediately after the warm-up, participants performed two to four countermovement jumps (CMJ).

Finally, participants were familiarized with the squat exercise on a Smith machine, with no counterweigh mechanism (Multi Exercitador, Righetto, São Paulo, Brazil). Each participant lowered with the barbell until reaching a knee angle of 90°, which was measured with a steel goniometer (BaseLine, Patterson Medical, Warrenville, Illinois, USA). An elastic band was placed on the Smith machine to determine the end of the eccentric phase and standardize squat depth for each participant. The participants completed ten repetitions without any load and it was required to lightly touch the elastic band during each repetition prior to performing the concentric phase. Afterward, mean bar displacement was calculated from the upright position to the bottom position in other five repetitions using a linear position transducer at a sampling rate of 1000 Hz (Chronojump, Barcelona, Spain).

Perceived stress

To monitor subjective stress, the *BPSS-10* was used, which is a valid and reliable stress scale, consisting of ten items of the adapted perceived stress scale (Reis et al. 2010). In this scale, participants described how often they experienced stressful situations in the last month. Six items are negative (1, 2, 3, 6, 9, 10) and the remaining four are positive (4, 5, 7, 8). The response format in each item was rated on a five-point Likert-type scale (1 = never to 5 = very often). To produce the final score, the four positive items were scored in reverse, and the remainder was summed to a score ranging from 0 to 40, with higher scores inferring elevated stress levels.

Vertical jump

The CMJ is a jump test used to determine lower body muscular power capacity, which was measured and analyzed with an iPhone 5S (Apple Inc, Cupertino, California, USA) via the app My Jump (Apple Inc, Cupertino, California, USA) (Balsalobre-Fernández et al. 2015). First, a standardized warm-up was undertaken for 2 min at a cadence of 50 rpm and at a load of ~ 50W on a cycle-ergometer (Model 828 E, Monark, Vansbro, Sweden). Subsequently, four repetitions of CMJ were performed with 1 min of passive recovery between each attempt. The average of the last two CMJs was used for analyses.

Isoinertial squat test

The isoinertial squat test involved squatting with increasing loads performed on a Smith machine (Multi Exercitador, Righetto, São Paulo, Brazil). The test uses submaximal loads and is an easy and simple way to measure the lower body strength without the risk of injury associated with high loads. An elastic band was placed on the Smith machine to standardize squat depth, as per the previous familiarization. Participants performed five sets with the following sequence: (1) five repetitions with the load of the bar (17 kg) at a free velocity; (2) five repetitions with ~ 30% of body mass at a free velocity; (3) five repetitions with 50% of body mass at a free velocity; (4) five repetitions with 50% of body mass at maximal voluntary velocity; and (5) five repetitions with 50% of body mass at maximal voluntary velocity. Participants had 2 min of passive recovery between sets. Mean velocity (MV), mean power (MP), and mean force (MF) during the concentric phase for each repetition were recorded with a linear position transducer (Chronojump, Barcelona, Spain). The mean values were considered because a recent work reported that MV might be the most appropriate variable for monitoring and testing load-velocity parameters (García-Ramos et al. 2018). Afterward, the mean of the last five repetitions for each variable was calculated and recorded.

Incremental endurance test

Adjustments in cycle-ergometer (Excalibur Sport, Lode BV, Groningen, Netherlands) were repeated according to the first session. The same protocol was used in previous studies (Gillen et al. 2016), and consisted of a warm-up of 1 min at 50 W with subsequent progressive increases of 1 W every 2 s until exhaustion or when pedal cadence fell below 50 rpm. The oxygen consumption (VO_2), carbon dioxide (CO_2) and ventilation (VE) were measured every 20 s using a metabolic cart (Cortex, Metalyzer, Leipzig, Germany) that was previously calibrated following manufacturer's instructions. The VO_{2max} was defined as the highest VO_2 value registered during a 20-s period and was confirmed when a minimum of two of the following criteria were met: (1) a respiratory exchange ratio (RER) higher than 1.2; (2) peak HR ≥ 90% of the age-predicted maximum (i.e. 220 minus age); and (3) visible exhaustion. Maximum power (P_{max}), and maximum RER (RER_{max}) were determined during a 20-s period at the end of the test.

HRV measurements

R–R intervals were recorded (RS800CX, Polar Electro Oy, Kempele, Finland) pre- and post-incremental tests during 10 min on a cycle-ergometer (Excalibur Sport, Lode BV, Groningen, Netherlands). Only the last 5 min of every recording was used for HRV analyses. Data collection was carried out with the participants pedaling at a steady cadence of 50 rpm with a load of 50 W. Subsequently, R–R data were transferred to a computer and filtered with specific software (Polar Pro-Trainer 5 version 5.40.170, Polar Electro Oy, Kempele, Finland). The filtered recordings were exported and analyzed with a custom-designed software (Kubios HRV Analysis version 3.0.2, The Biomedical Signals Analysis Group, University of Kuopio, Finland). The variables selected for analyses were: (1) R–R intervals (R–R); (2) standard deviation of all R–R intervals (SDNN); (3) root mean square of successive differences between R–R intervals (RMSSD); and (4) detrended fluctuations of short-term fractal scaling (α1) (Boullosa et al. 2014).

Blood redox status

Pre- and post-30 min to the incremental test, blood collection was applied from the antecubital vein, using disposable syringes of 10 ml. The blood was stored in two empty Vacutainer® 4-ml EDTA tubes (Becton–Dickinson, Franklin Lakes, New Jersey, USA). All blood samples were stored at 5 °C and were centrifuged at 3000 rpm for 10 min, with plasma separated in triplicates (1.5-ml tubes). Subsequently, the blood samples were stored at − 80 °C for further analysis of antioxidant enzymes such as catalase (CAT) and superoxide dismutase (SOD), as well as glutathione levels (GSH), thiobarbituric acid reactive substances (TBARS), and uric acid (UA). CAT activity was measured using the Amplex™ Red CAT assay kit (Thermo fisher Scientific®, MA, USA) with a final spectrophotometric reading with 1-min incubation at 560 nm. The GSH levels and SOD activity were measured using the GSH and SOD assay kits from Sigma-Aldrich® (St. Louis, MO, USA), with a final spectrophotometric reading at 450 nm. The formation of TBARS to estimate oxidative damage was measured using a protocol adapted from Ohkawa et al. (1979).

Anaerobic performance

Ten-minute post-incremental test, participants were evaluated in two "all out" sprints of 5 s with 24 s of recovery. The torque factor was set to 0.7 N·m (Wingate for Windows software version 1, Lode BV, Groningen, Netherlands). Two seconds before every effort, the load was applied and participants were asked to achieve the highest possible pedaling frequency and to maintain it until the end. The peak power (PP), total work (TW), and maximal pedaling rate (RPM_{max}) were recorded during each effort. PP was the highest single value of power output, TW was obtained by multiplying mean power by the duration of the bout, and RPM_{max} was the maximum number of revolutions per minute achieved. The mean of the two sprints was calculated for further analyses.

Incidental PA

PA was measured during the training period with an accelerometer (GT1M, Actigraph, LCC, Fort Walton Beach, Florida, USA) during 7 consecutive days. Participants were instructed to use the monitor on their right hip and to only remove it for sleeping or taking baths. Epoch lengths were selected at 15 s and summed as counts per minute. The cut-points to identify time spent in different intensities of PA were: (1) light < 1951 counts/min; (2) moderate 1952–5724 counts/min; (3) vigorous 5725–9498 counts/min; and (4) very vigorous > 9499 counts/min. The average energy expenditure (EE) in kcals/day was also calculated (Freedson et al. 1998).

Dietary intake

Before the first testing day, participants listed all food and drink ingested in the last 24 h using a food recall questionnaire. It was requested to repeat these patterns 24 h before the final day of evaluations. In addition, during the training period, participants tracked their dietary intake for six random days (4 days a week and 2 days of the weekend). To improve the quality of information, participants were asked to take pictures of each food intake during the selected day and send them by cell phone to the researcher. A dietician instructed participants how to complete the food diary, and analyzed the information referent to total kcals, proteins, carbohydrates, fats, vitamin C, vitamin E, and vitamin A intake using a custom software (Smart data, São Paulo, Brazil). The average of 6 days for macronutrients and micronutrients were subsequently calculated.

Training programs

The training programs involved three sessions per week for 2 weeks. RTG trained the squat exercise in a Smith machine (Multi Exercitador, Righetto, São Paulo, Brazil) with a load equivalent to 50% of the body mass. This exercise was chosen because a recent study reported that multi-joint exercises could be better to enhance general fitness (Paoli et al. 2017), and that heavy-load resistance training causes greater interferences on the quality of endurance training sessions (Doma et al. 2017). The SITG trained in a cycle-ergometer with a torque factor 0.7 N·m. CTG combined SIT in cycle-ergometer followed by the squat exercise. It has been previously suggested that both exercise modes (i.e. squat and sprint) have a similar muscle activation nature (Bloomer et al. 2006). This intra-session sequence was selected based on previous studies (Fyfe et al. 2016; Varela-Sanz et al. 2017). The recovery between sessions was 48–72 h. An undulating periodization (Rhea et al. 2002) with 6–12 sets (6 sets in 1st and 2nd sessions, 12 sets in 3rd, 4th and 5th sessions, and 6 sets in the 6th session) was performed. In the last session, the volume was reduced to ensure supercompensation. Every set had a 5-s "all out" effort with 24 s of recovery (Benitez-Flores et al. 2018).

The warm-up and the cooling down were on a cycle-ergometer at ~50 W with 50 rpm, with duration of 2 and 3 min, respectively (Excalibur Sport, Lode BV, Groningen, Netherlands and Model 828 E, Monark, Vansbro, Sweden). In the middle of every session, 3 min of active recovery was applied because the mechanical production seems to decrease over SIT sessions (Hazell et al. 2010; Islam et al. 2017; Benitez-Flores et al. 2018). The recovery of RTG and SITG was performed in the cycle-ergometers with the same load of the warm-up, whilst recovery during CTG was completed by walking at a self-selected velocity from one laboratory to another. The training protocols were equated by time, with the same work-to-rest ratio:

(1) 6 sets × 5 s × 24 s of recovery = 5 min 6 s of exercise (30 s of bouts and 4 min 36 s of recovery), and 10 min 6 s for total time (5 min 6 s of exercise, 2 min of warming up and 3 min of cooling down);
(2) 12 sets × 5 s × 24 s of recovery = 8 min of exercise (1 min of bouts and 7 min of recovery), and 13 min for total time (8 min of exercise, 2 min of warming up and 3 min of cooling down).

A similar volume of total time training was used in previous studies showing improvements in cardiometabolic health indices (Metcalfe et al. 2012; Gillen et al. 2016; Jabbour et al. 2018).

Training monitoring

The 2nd, 3rd, 5th and 6th sessions were selected to monitor internal (1 and 2) and external (3) load parameters with three different tools: (1) the *Category-ratio 10 scale rating of perceived exertion* (*CR-10 RPE*) (Borg et al. 1998); (2) the mean HR (HR_{mean}) during sessions (Polar Pro-Trainer 5 version 5.40.170, Polar Electro Oy, Kempele, Finland); and (3) the TW. During RTG and CTG sessions, the number of repetitions completed in every set in the squat exercise, served to calculate the TW per session, according to the formula: work (kJ) = *1.33* × displacement (m) × [(body mass (kg)*0.88) + load (kg)] × 9.81 (Bloomer et al. 2006). For SITG, TW of the session was calculated by summing the work of all sprints (Excalibur Sport, Lode BV, Groningen, Netherlands). For CTG, the TW of both exercises was summed. Then, the mean of *CR-10 RPE*, HR_{mean} and TW was calculated during the four selected sessions for further comparisons.

Statistical analyses

Data are presented as mean ± SD. Normality was assessed by means of standard distribution measures, visual inspection of *Q–Q* plots and box plots, and the Shapiro–Wilk test. Variables with a non-normal distribution were log-transformed (Ln) for analysis (Hopkins et al. 2009). Where normalization was not possible for some variables, non-parametric methods were used. The intergroup differences in incidental PA and training monitoring were evaluated via one-way ANOVA. Also, exact P value differences between groups were determined from non-paired t tests with Bonferonni's correction. The intergroup differences in dietary intake were evaluated via Kruskal–Wallis test. The effect of training interventions in perceived stress, vertical jump and anaerobic performance was evaluated by a two-way ANOVA with a repeated measures factor of two levels (time) and intersubject factor of three levels (group). If appropriate, post hoc analyses were conducted using paired t tests with

Bonferroni's adjustment. As normality assumption was not satisfied for body composition, isoinertial squat test, and incremental endurance test, a non-parametric ANOVA-type statistics (time × group) was conducted using the nparLD R software package (Noguchi et al. 2012). Non-parametric ANOVA-type statistics allows the same analysis as traditional ANOVA (i.e. the effect of each factor and interaction between them) but is based on the use of ranks for calculating the so-called 'relative marginal effects' (Noguchi et al. 2012). When a significant interaction was detected, paired comparison within groups (i.e. after vs. before) was applied using the Wilcoxon signed-rank test and paired comparison between groups using the Mann–Whitney *U* test with Bonferroni's adjustment. For HRV parameters and redox status, a 4 × 4 (time × group) parametric or non-parametric ANOVA were performed when appropriate. Cohen's *d* (for normal variables) and $r = z/\sqrt{N}$ (for non-normal variables) were calculated for ES analyses representing ≤ 0.20 as a small effect, 0.50 as a medium effect, and ≥ 0.80 as a large effect (Cohen 1988). A post hoc power analysis was calculated using the G*Power software (version 3.1.9.2). The statistical power values for an ANOVA within–between interaction for a total sample of 30 subjects, four groups, two measurements (i.e. pre-test vs. post-test), an alpha level of 0.05, and a correlation between repeated measurements of 0.7 were 0.79 and 0.99 for a medium ($f = 0.25$) and a large ($f = 0.40$) effect sizes, respectively. In addition, we calculated the sensitivity of the ANOVA to detect within–between interactions for an alpha level of 0.05, a power of 0.80, a total sample of 30 subjects, four groups, two measurements within groups, and a correlation between repeated measurements of 0.7, and it was obtained that the test was sensitive to detect a medium effect size ($f = 0.252$). The statistics were performed with the software IBM SPSS Statistics for Windows Version 23 (IBM Corporation, Armonk, New York, USA) and the nparLD R software package. All graphics were made with GraphPad Prism 6 (GraphPad Software, San Diego, CA, USA). The alpha level was set at $P < 0.05$.

Results

During the testing sessions, three participants (one from RTG, one from SITG, and one from CTG) dropped out because of a disease and some injuries not related to this study. Thus, 30 participants (15 females, 15 males) aged 19–35 years (25.3 ± 4.5 years) composed the groups that presented similar sex distribution (50%): RTG (26 ± 4.1 years, $n = 8$), SITG (25.3 ± 5.3 years, $n = 8$), CTG (23.6 ± 4.8 years, $n = 8$), and CONG (26.2 ± 3.9 years, $n = 6$). No between-group differences were found at baseline for all parameters analyzed ($P > 0.05$). All these participants completed 100% of the training sessions.

Body composition

For body mass, neither main effects nor time × group interaction was detected ($P > 0.05$). Regarding BMI, a significant effect of group was observed ($P = 0.004$). Post hoc analyses showed lower values for CONG in comparison with the experimental groups. Neither main effect of time nor time × group interaction was observed ($P > 0.05$). There was a main effect of time ($P \leq 0.001$) for body fat (%), with lower values after training whereas neither main effect of group nor time × group interaction was detected ($P > 0.05$) (Table 1).

Vertical jump

There were no main effects of time and group ($P > 0.05$) for CMJ height. However, a significant interaction was found ($F = 3.653$; $P = 0.025$) for CMJ height. Pairwise comparison showed an increment in RTG ($P = 0.037$; $d = 0.31$) but not in SITG ($P = 0.232$; $d = -0.11$), CTG ($P = 0.100$; $d = 0.18$) or CONG ($P = 0.982$; $d = 0.01$) (Fig. 2). No intergroup differences were found at any time ($P > 0.05$).

Anaerobic performance

There was a main effect of time ($P < 0.001$), but neither main effect of group nor interaction ($P > 0.05$) was observed for PP, TW and RPM_{max} (Table 1).

Isoinertial squat test

There were a significant main effect of time ($P = 0.021$) and time × group interaction ($F_{1.97,\infty} = 4.702$; $P = 0.005$) for MV.

Pairwise comparisons detected higher values after training for RTG ($P = 0.017$; $r = 0.84$) but not for SITG ($P = 0.731$; $r = 0.22$), CTG ($P = 0.123$; $r = 0.54$) or CONG ($P = 0.345$; $r = 0.38$). There were a significant main effect of time ($P = 0.014$) and interaction ($F_{2.81,\infty} = 5.215$; $P = 0.002$) for MP. Post hoc pairwise comparisons detected significant improvements after training for RTG ($P = 0.017$; $r = 0.84$) and CTG ($P = 0.036$; $r = 0.74$), but not for SITG ($P = 0.674$; $r = 0.15$) and CONG ($P = 0.600$; $r = 0.21$). A significant main effect of time ($P < 0.001$) and interaction ($F_{1.97,\infty} = 2.616$; $P = 0.004$) were observed for MF. Higher values after training were detected for RTG ($P = 0.012$; $r = 0.89$) and CTG ($P = 0.012$; $r = 0.89$), but not in SITG ($P = 0.161$; $r = 0.49$) and CONG ($P = 0.345$; $r = 0.38$). No main effect of group was found for any of these variables ($P > 0.05$) (Fig. 3).

Incremental endurance test

Significant main effect of time ($P = 0.016$) and time × group interaction ($F_{2.89,\infty} = 3.075$; $P = 0.030$) were detected for

Table 1 Body composition and cycling performance parameters

Parameter	RTG ($n=8$)		SITG ($n=8$)		CTG ($n=8$)		CONG ($n=6$)	
	Before	After	Before	After	Before	After	Before	After
Body composition								
Body mass (kg)	76.5 ± 18.6	76.6 ± 19.4	74.9 ± 16.3	74.9 ± 16.9	66.9 ± 9	67.5 ± 8.9	60.8 ± 6	60.7 ± 5.9
BMI (kg m^{-2})	25.1 ± 4.1	25.1 ± 4.3	25.9 ± 3.8	25.9 ± 4	23.2 ± 1.8	23.4 ± 1.9	21 ± 1.4	20.9 ± 1.4
Body fat (%)	23.1 ± 5.2	22.4 ± 6	26.1 ± 11	25.4 ± 12.1	22.4 ± 8.8	21.2 ± 8.9	18.9 ± 10.6	17.5 ± 9.6
Incremental test								
VO_{2max} (ml kg^{-1} min^{-1})†	33.6 ± 6.3	35 ± 5.6	35.5 ± 7.5	38.1 ± 8*	35.3 ± 6.4	37.4 ± 6.9*	34.2 ± 5.9	33 ± 5.4
P_{max} (W)	241 ± 61.4	249.7 ± 60.2	237.2 ± 51.1	246 ± 54.5	216 ± 45.3	224.7 ± 50.6	194.3 ± 37.6	199.3 ± 38.8
RER_{max}	1.20 ± 0.12	1.20 ± 0.06	1.19 ± 0.07	1.21 ± 0.09	1.20 ± 0.08	1.22 ± 0.1	1.29 ± 0.16	1.31 ± 0.17
Anaerobic performance								
PP (W)	764 ± 288.8	817.6 ± 303.3	802.6 ± 269.7	865.3 ± 278	725.7 ± 225.6	852.7 ± 269	668.5 ± 209.4	694 ± 173.8
TW (kJ)	3.1 ± 1.1	3.2 ± 1.2	3.3 ± 1	3.6 ± 1.1	3 ± 0.8	3.5 ± 0.9	2.7 ± 0.8	2.8 ± 0.6
RPM_{max}	117.2 ± 17	124.2 ± 22.7	124 ± 17.4	135 ± 19.7	125.7 ± 12.5	136.7 ± 19.4	123.2 ± 21.8	125 ± 17.9

Data are mean ± SD

RTG resistance training group, *SITG* sprint interval training group, *CTG* concurrent training group, *CONG* control group, VO_{2max} maximum oxygen consumption, P_{max} maximum power, RER_{max} maximum respiratory exchange ratio, *PP* peak power, *TW* total work, RPM_{max} maximal pedaling rate

$^{\dagger}P<0.05$ main effect of interaction; $*P<0.05$ before vs. after intragroup differences

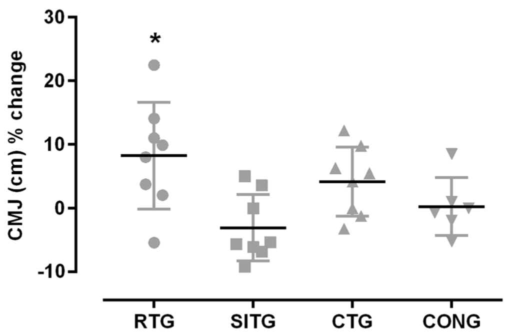

Fig. 2 Percentage (%) change before vs. after in countermovement jump (CMJ) for all groups. *RTG* resistance training group, *SITG* sprint interval training group, *CTG* concurrent group, *CONG* control group. $*P<0.05$ before vs. after intragroup differences

VO_{2max}. Significant improvements were observed in SITG ($P=0.012$; $r=0.89$) and CTG ($P=0.042$; $r=0.72$), but not in RTG ($P=0.093$; $r=0.59$) and CONG ($P=0.345$; r=-0.38) (Fig. 4). No main effect of group was found ($P>0.05$). Regarding P_{max}, only a main effect of time ($P<0.001$) was obtained, whereas neither group nor time × group interaction was observed ($P>0.05$). No significant effect was detected for RER_{max} ($P>0.05$) (Table 1).

Training monitoring

No significant differences were observed between groups in TW during the training period (RTG: 25.2 ± 9.2; SITG: 26.4 ± 8.8; CTG: 24.4 ± 6.5 kJ; $P>0.05$). Significant differences were found in HR_{mean} (RTG: 123 ± 15; SITG: 142 ± 13; CTG: 137 ± 10 b·min^{-1}; $P=0.013$) for RTG vs. SITG ($P=0.013$; $d=-1.35$) and RTG vs. CTG ($P=0.033$; $d=-1.10$). In addition, significant differences were observed in *CR-10 RPE* (RTG: 3.9 ± 1; SITG: 7 ± 1.4; CTG: 4.2 ± 1.2; $P<0.001$) for RTG vs. SITG ($P<0.001$; $d=-2.55$) and CTG vs. SITG ($P<0.001$; $d=-2.14$).

Perceived stress

There was a main effect of time ($P=0.002$), but neither main effect of group nor time × group interaction ($P>0.05$) was found for *BPSS-10*.

Incidental PA

A significant difference was observed in the % time spent at moderate intensity ($P=0.024$). A difference was observed between SITG and CTG ($P=0.004$; $d=-1.66$) (Table 2).

Dietary intake

There were no significant differences in dietary intake between groups during the training period ($P>0.05$) (Table 2).

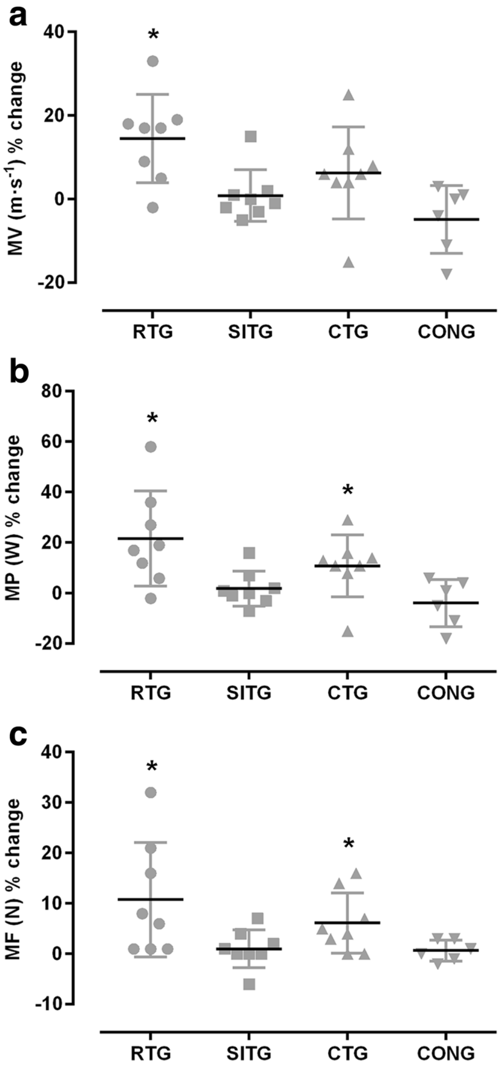

Fig. 3 Percentage (%) change before vs. after in mean velocity (MV) (**a**), mean power (MP) (**b**), and mean force (MF) (**c**) in isoinertial squat test for all groups. *RTG* resistance training group, *SITG* sprint interval training group, *CTG* concurrent training group, *CONG* control group. *$p < 0.05$ before vs. after intragroup differences

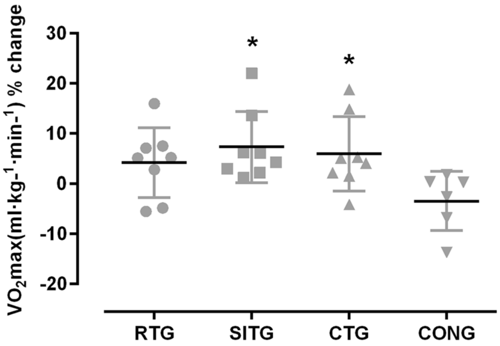

Fig. 4 Percentage (%) change before vs. after in maximum oxygen consumption (VO_{2max}) for all groups. *RTG* resistance group, *SITG* sprint interval training group, *CTG* concurrent group, *CONG* control group. *$P < 0.05$ before vs. after intragroup differences

HRV measures

There was a main effect of time ($P \leq 0.001$) in all the variables (i.e. R–R, SDNN, RMSSD and α1), but neither main effect of group nor interaction was detected ($P > 0.05$).

Redox status

Data from two participants for each experimental group were lost. There were significant main effects of time ($P < 0.001$) and group ($P = 0.029$), and a time × group interaction ($F_{4.31,\infty} = 14.883$; $P < 0.001$) for CAT. Post hoc pairwise comparisons detected significant increments in all the experimental groups for CAT before and after training at pre- and post-incremental tests ($P < 0.001$; $d \geq 2.30$). For GSH, significant main effects of time and group, and a time × group interaction ($F_{9,78} = 37.033$; $P < 0.001$) were found. Post hoc analysis detected a significant increase in all the experimental groups for GSH before and after training at pre- and post-incremental tests ($P < 0.05$; $d \geq 2.02$). For SOD, a significant main effects of time and a time × group interaction ($F_{9,78} = 7.418$; $P < 0.001$) were observed, without main effect of group ($P = 0.361$). Post hoc intragroup comparisons revealed a significant increment in all the experimental groups for SOD before and after training at pre- and post- incremental tests ($P < 0.05$; $d \geq 1.74$) (Fig. 5). For UA, significant main effects of time, group and a time × group interaction ($F_{9,78} = 11.513$; $P < 0.001$) were detected. Subsequent post hoc analysis showed that there were no intragroup differences ($P > 0.05$). Finally, for TBARS, no significant effects were observed ($P > 0.05$).

Discussion

This is the first study that compared time-matched high-intensity programs utilizing very short "all out" efforts during single vs. concurrent exercise modes on physical and physiological parameters. The main finding was that CTG improved similarly to the other exercise groups (RTG and SITG), lower body strength, aerobic capacity and redox status. Furthermore, this work is the first to control confounding variables such as dietary intake, incidental PA, and perceived psychological stress that could interfere with physiological adaptations.

The chronic interference hypothesis postulates that high volume or intensity of training could promote overreaching or overtraining, thus inducing competing responses when

Table 2 Incidental physical activity and dietary intake

	RTG ($n = 8$)	SITG ($n = 8$)	CTG ($n = 8$)	CONG ($n = 6$)
Incidental physical activity				
kcal day^{-1}	333.7 ± 185	403.9 ± 241.1	386.3 ± 214.1	219.9 ± 59.7
% in sedentary domain	83 ± 8.3	86.6 ± 4.3	82 ± 5.7	85.1 ± 6
% in light domain	13.7 ± 7.9	11.2 ± 4.1	13.7 ± 4.7	11.6 ± 4.4
% in moderate domain†	3 ± 1.5	1.9 ± 0.8	4 ± 1.6*	3.1 ± 1.5
% in vigorous domain	0.2 ± 0.2	0.3 ± 0.7	0.3 ± 0.3	0.2 ± 0.3
Dietary intake				
kcal day^{-1}	1505.3 ± 300.2	1858.6 ± 771.9	1764.1 ± 870.7	1584.1 ± 449.9
g day^{-1} of protein	71.8 ± 26.3	85.9 ± 30.4	76.2 ± 34.9	71.5 ± 20.3
g day^{-1} of carbohydrate	180 ± 45.2	213.3 ± 96.1	234 ± 114.6	209.7 ± 55
g day^{-1} of fat	55.8 ± 14.5	74.2 ± 34.9	58.8 ± 32.4	51.8 ± 20.7
mg of vitamin C	71.5 ± 54.8	76.6 ± 42.2	124.4 ± 93.4	140.8 ± 61.2
mg of vitamin E	7.1 ± 4.6	5.3 ± 2.2	7.1 ± 6.6	5.4 ± 3.4
μg of vitamin A	144.6 ± 103.9	159 ± 99.5	210.2 ± 106.5	126.4 ± 123.3

Data are $M \pm$ SD

RTG resistance group, *SITG* sprint interval training group, *CTG* concurrent group, *CONG* control group

$^{\dagger}P < 0.05$ intergroup differences; $^{*}P < 0.05$ differences from SITG

strength and endurance training are performed concomitantly (Wilson et al. 2012; Doma et al. 2017). Recently, a meta-analysis concluded that integrating HIIT in concurrent regimes could impede the development of lower body strength, with a trend for more negative effects detected when performing cycling HIIT (Sabag et al. 2018). Similarly, Doma et al. (2017) have suggested that RT-induced fatigue may impair the quality of endurance training sessions, thereby limiting the optimization of endurance development. In this regard, concomitantly training very short duration sprinting and resistance exercise bouts might promote a lower interference effect as they produce similar neuromuscular demands (Wilson et al. 2012). For instance, two previous studies reported that modified SIT of 20 s did not impair the gains in maximum strength of upper and lower limbs (Cantrell et al. 2014; Laird et al. 2016). The current findings are in line with these previous studies (Cantrell et al. 2014; Laird et al. 2016), as CTG improved power and force in the squat exercise to a similar extent than RESG. Furthermore, the present study demonstrated that performing cycling training prior to strength training did not impede on lower body strength development as previously reported (Eddens et al. 2017; Sabag et al. 2018). It is probable that the lower level of endurance training volume employed in the current study, compared to that of previous studies (Coffey and Hawley 2017; Eddens et al. 2017; Sabag et al. 2018), mitigated potential interference on strength development (Doma et al. 2017). This training sequence (i.e. endurance prior to strength training) has also been confirmed to minimize carry-over effects of fatigue between training modes, given that muscular contractility is better preserved by incorporating endurance training prior to strength training performed on the same day (Doma and Deakin 2013).

Previously, it has been suggested that the combination of short sprints with high-intensity resistance exercise can be effective for promoting enhancements in running sprint velocity and maximum strength (Ross et al. 2009). In fact, this combination could be even better since shorter sprints promote lesser homeostatic disturbances and residual fatigue than SIT with longer bouts (Balsom et al. 1992a; Benitez-Flores et al. 2018). Further, it may be suggested that the current RT protocol performed with a low external load could minimize RT-induced fatigue, compared to traditional RT methods with heavy loads, therefore, optimizing the quality of SIT sessions and lower interference of endurance adaptations (Doma et al. 2017). This point is relevant, as muscle power is the parameter most negatively affected by CT (Wilson et al. 2012). Moreover, the CTG improved VO_{2max} to a similar extent as the SITG, therefore, demonstrating a similar adaptation with no interference effect observed for both anaerobic and aerobic performances. It has recently been shown that limiting velocity loss during training sets generates positive changes in the force–velocity curve and preserves the percentage of myosin heavy chain IIx (Pareja-Blanco et al. 2017). Therefore, considering that both RT and SIT were performed with very short efforts in the current study, this could be a key factor for CTG inducing both neuromuscular and aerobic adaptations to similar levels as SITG and RTG.

RTG was the only group that showed a significant increase in CMJ height after training (~ 8%). This is in agreement with other works that compared concurrent HIIT and RT (Chtara et al. 2008; Fyfe et al. 2016). These

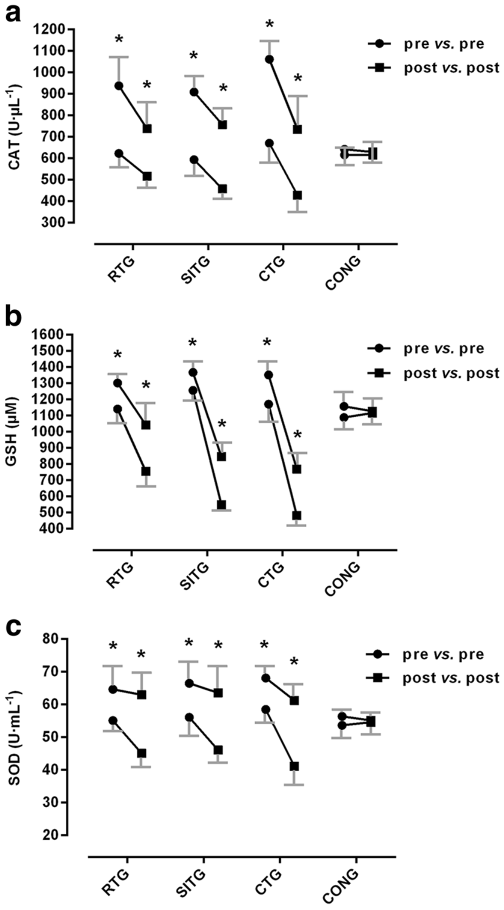

Fig. 5 Catalase (CAT) (**a**), glutathione peroxidase (GSH) (**b**), and superoxide dismutase (SOD) (**c**) response before and after training (pre- vs. pre- and post- vs. post-incremental test) for all groups. *RTG* resistance group, *SITG* sprint interval training group, *CTG* concurrent group, *CONG* control group. $*P<0.05$ before vs. after intragroup differences

results suggest that the particular training stimuli and volume could be important to potentiate some neuromuscular adaptations. The principle of training specificity indicates that performance enhancements are related to the modality used, depending on the muscular actions involved, speed of movement, range of motion, energy systems and loading patterns (Kraemer and Ratamess 2004). Despite that both cycling and squatting exercises having biomechanical similarities (Bloomer et al. 2006; Wilson et al. 2012) and were completed at high power levels, we speculate that the force-vector application and specific volume might have a role in transference adaptations and CMJ performance changes (Gonzalo-Skok et al. 2016). In contrast to previous literature on SIT (Sloth et al. 2013), we did not find any improvement in anaerobic performance during a supramaximal effort. Previously, it was reported that modified SIT can increase power output in the short term (Hazell et al. 2010; Zelt et al. 2014; Kavaliauskas et al. 2015; Yamagishi and Babraj 2017; Olek et al. 2018) which has not been confirmed in our data. While we do not know the exact reason for this discrepancy with previous literature, it could be speculated that lower TW (~25 kJ vs. 38–59 kJ) (Hazell et al. 2010; Yamagishi and Babraj 2017) and work-to-rest ratio (1:5 vs. 1:8) (Kavaliauskas et al. 2015) performed in the current study when compared to previous ones could be the reason behind this absence of significant improvements. Further studies should verify this issue while controlling other methodological aspects as exercise order during evaluations, and other factors affecting fatigue and recovery.

Another relevant component of our study is that a modified, short version of a HIIT protocol (~13 min) was sufficient to improve VO_{2max} in both SITG and CTG. This training method has a practical significance, since Vollaard and Metcalfe (2017) suggested that shorter sessions could remove many of the common barriers for adhering to regular exercise. Thus, the current study demonstrates the importance of identifying the smallest dose of sprint training required to optimize health benefits (Carrasco 2017). In fact, the TW (~25 kJ) in our proposal was lower to those completed in previous studies using modified SIT (Gillen et al. 2016) and classical SIT (Burgomaster et al. 2008). In addition, both groups maintained a higher HR_{mean} during sessions, representing ~80% of maximum HR. This is in line with previous research with very short sprints in which participants spent several minutes per session near the "red zone" (i.e. ~90% VO_{2max}) (Benitez-Flores et al. 2018), allowing sufficient training stimuli to the cardiopulmonary system (Buchheit and Laursen 2013). Enhancements of cardiorespiratory fitness has already been established utilizing a low volume of adapted SIT (Metcalfe et al. 2012, 2016; Gillen et al. 2016). However, this is the first report with similar increments combining both SIT and RT. Thus, the modifications observed in VO_{2max} (~7%) in the current study are comparable to those found after the same period of time using classical SIT (Whyte et al. 2010; Astorino et al. 2011), and HIIT (Lanzi et al. 2015), and can be explained by several central (Matsuo et al. 2014) and peripheral adaptations (Sloth et al. 2013). Our observations also have substantial clinical relevance, because a ~3.5 ml kg^{-1} min^{-1} increase in VO_{2max} is associated with a 13% and 15% lower risk of all-cause mortality and cardiovascular events, respectively (Kodama et al. 2009). Therefore, according to the present findings and the information provided by others (Vollaard and Metcalfe 2017), it could be suggested that both SIT and CT performed with very short efforts are adequate methods to induce cardiorespiratory adaptations after only six sessions.

Exercise-induced reactive oxygen species production is fundamental to oxidative metabolism and redox homeostasis, having important clinical implications, as they regulate the pathophysiology of cardiometabolic diseases (Radak et al. 2013). High-intensity exercise could potentiate the antioxidant response when compared to low-intensity exercise. For instance, Parker et al. (2018) recently showed that SIT promoted superior acute alterations in biomarkers of redox homeostasis compared to extensive HIIT and moderate-intensity continuous training. Bogdanis et al. (2013) reported that nine sessions of classical SIT attenuated oxidative stress and up-regulated antioxidant activity, similar to what was previously observed by Fisher et al. (2011) with HIIT. The current results align with this benefit of high-intensity exercise on redox status, since the three training groups significantly improved endogenous antioxidant defense after the training period. These findings provide novel support for the use of very short, "all out" bouts with different exercise modes, as a valid option for promoting protection against cardiometabolic diseases associated with oxidative stress. Furthermore, to the best of our knowledge, this is the first study to exhibit enhancements in the antioxidant profile after only 2 weeks of training, which demonstrates a very time-efficient training approach (~36 min/week) for improving health outcomes.

Surprisingly, there were no improvements in autonomic control of HR in any group after training. Our results differ with previous literature showing improvements in HRV indices after the application of supramaximal bouts during 2 weeks (Kiviniemi et al. 2014; de Sousa et al. 2018), which have been associated with changes in the aerobic capacity (Kiviniemi et al. 2015). In contrast, we found improvement in VO_{2max} without significant alterations in HRV indices. While these results are difficult to explain as a number of methodological aspects could be involved (e.g. posture, HRV indices selected, workload, etc.), it could be speculated that the lower metaboreflex stimulation in present training protocols primarily contributed to these trends. Since our protocols are expected to promote lower glycolytic activation and, therefore, lower lactate production (Benítez-Flores et al. 2018), a lower metaboreflex stimulation could have occurred during sessions when compared to previous studies (Kiviniemi et al. 2014; de Sousa et al. 2018), thereby limiting autonomic adaptations after only six sessions (Stanley et al. 2013). Further studies with different glycolytic activity levels should be performed for appropriately testing this hypothesis.

The present study demonstrates several strengths that should be highlighted. First, all participants from the experimental groups completed each session that were time matched for volume of training, reaching a similar total external workload as confirmed by the non-significant differences between groups in TW. This issue is very important because the lack of criteria when comparing divergent training proposals has been suggested to be an important flaw in CT studies (Leveritt et al. 1999; Fyfe et al. 2014; Coffey and Hawley 2017). In this regard, the differences observed in *CR-10 RPE* and HR_{mean} between groups allow appropriate comparisons of both external and internal workloads between groups, thereby highlighting greater efficiency of the CTG. Furthermore, our results demonstrate greater validity since three potentially confounding factors, including incidental PA, diet, and psychological subjective stress perceived by participants during the experimentation period, were objectively controlled with comparable measures between groups. The percentage of time at moderate intensity of incidental PA was the only measure reported to be different between SITG and CTG, which does not likely affect the conclusions.

There are also some limitations in the current study that should be mentioned. First, the number of participants in each group was reduced during the trial, and some samples were lost in the case of redox status. Further studies should verify if the current findings could be confirmed with greater samples. Second, the training period was shorter than most training studies and, therefore, it is not possible to make inferences about what would happen if these interventions would be prolonged. Third, we only recorded HRV on a single day during submaximal exercise; therefore, further studies should determine if autonomic adaptations may be detected in resting and ambulatory conditions over various days (Tonello et al. 2016). Finally, the participants in these studies were young, physically active and healthy. Therefore, the current results could not be extrapolated to other populations (e.g. older populations and/or those with clinical conditions). Further studies with other populations should be conducted over more weeks to determine the efficacy of the current exercise intervention.

Conclusion

In summary, we have examined, for the first time, the benefit of applying high-intensity, very short "all out" efforts on physical and physiological adaptations, using various exercise modes with equivalent workload. The results of this study suggest that the concurrent protocol promotes benefits in neuromuscular performance (i.e. lower body strength) and cardiometabolic health (i.e. aerobic capacity and the redox status) with a lower perceived demand (i.e. *CR-10 RPE*). Interestingly, we did not observe any dropout and adverse events during the intervention period. For this reason, this type of high-intensity protocols could be very important for public health policies with the aim to improve adherence to exercise. Future studies should explore the likely positive effect of programs with very short bouts over longer periods; and to examine these changes in sedentary and clinical populations, especially those with cardiometabolic disorders, in contexts where sophisticated exercise equipment is not necessary. Given that the 'Paleo hypothesis' (Boullosa et al. 2013) states that the polarized intensity distribution of combined PA and exercise would result in greater physiological adaptations and subsequent performances in the long term, furthers studies should elaborate on the chronic effects of these type of SIT protocols when combined or not with other exercises and PA patterns for appropriately testing this hypothesis.

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Author contributions SB-F, DAB, and TSR conceived the study design. SB-F, ARM, and TSR conducted the experiments. SB-F and EI-S conducted the statistical analyses. SB-F, EI-S, TSR, KD and DAB interpreted the results. SB-F, FAV, EI-S, TSR, ARM, KD and DAB: wrote the manuscript. All authors read and approved the final manuscript version.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval All procedures performed were in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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REVIEW

WILEY

Effects of short sprint interval training on aerobic and anaerobic indices: A systematic review and meta-analysis

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The effects of short sprint interval training (sSIT) with efforts of ≤10 s on maximal oxygen consumption ($\dot{V}O_2$max), aerobic and anaerobic performances remain unknown. To verify the effectiveness of sSIT in physically active adults and athletes, a systematic literature search was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). The databases PubMed/MEDLINE, ISI Web of Science, and SPORTDiscus were systematically searched on May 9, 2020, and updated on September 14, 2021. Inclusion criteria were based on PICO and included healthy athletes and active adults of any sex (≤40 years), performing supervised sSIT (≤10 s of "all-out" and non-"all-out" efforts) of at least 2 weeks, with a minimum of 6 sessions. As a comparator, a non-sSIT control group, another high-intensity interval training (HIIT) group, or a continuous training (CT) group were required. A total of 18 studies were deemed eligible. The estimated SMDs based on the random-effects model were −0.56 (95% CI: −0.79, −0.33, $p < 0.001$) for $\dot{V}O_2$max, −0.43 (95% CI: −0.67, −0.20, $p < 0.001$) for aerobic performance, and −0.44 (95% CI: −0.70, −0.18, $p < 0.001$) for anaerobic performance after sSIT vs. no exercise/usual training. However, there were no significant differences ($p > 0.05$) for all outcomes when comparing sSIT vs. HIIT/CT. Our findings indicate a very high effectiveness of sSIT protocols in different exercise modes (e.g., cycling, running, paddling, and punching) to improve $\dot{V}O_2$max, aerobic, and anaerobic performances in physically active young healthy adults and athletes.

KEYWORDS
aerobic fitness, anaerobic fitness, high-intensity interval training, human performance, sprint interval training

1 | INTRODUCTION

Traditionally, high-intensity interval training (HIIT) consists of bouts of cyclic endurance exercises at intensities above the lactate threshold or critical power, interspersed with active or passive rest intervals. The main purpose of HIIT is to complete a greater amount of work at a high-intensity when compared to a single continuous bout at the same intensity until exhaustion.[1] This training modality was initially developed for endurance runners,[2] but, to date, it is commonly used in both individual and team sports,[3] and in clinical practice,[4] to enhance both aerobic and anaerobic fitness components.[5] Although athletes typically combine HIIT with other training modalities for fitness development, there is the consensus that it allows rapid metabolic and neuromuscular adaptations already after a few brief sessions when compared to continuous endurance training methods.[6] For this reason, HIIT has become a very popular training modality, not only in recreational and elite sport but also for health purposes in the general population.

Among the HIIT loading parameters that can be manipulated, intensity appears to be most important as the different HIIT modalities are directly linked to manipulation of internal (e.g., HR) and external (e.g., power) loading parameters.[1,3,7] Thus, in the supramaximal zone (i.e., above the maximal oxygen consumption; $\dot{V}O_2max$) of HIIT intensities, we may refer to the intermittent methods in the classic terminology,[1] which includes HIIT with short intervals. Training at "all-out" maximal effort using repeated-sprint training (RST) and sprint interval training (SIT) are other HIIT modalities following the classification by Buchheit and Laursen.[3] However, there is no consensus regarding the HIIT and SIT definitions in the literature.[1] While RST (≤10 s) and SIT (≤45 s) may refer to "all-out" efforts of varying duration, HIIT with short intervals is commonly performed at non-"all-out" efforts of short duration (≤10 s).[3] For this reason, HIIT protocols as RST and SIT do not require identification of metabolic parameters and power output for training prescription, while HIIT with short intervals requires, at least, the identification of a parameter associated with aerobic power.

Recently, it has been suggested that sessions with less and shorter (i.e., 4–20-s) sprints are a more time-efficient HIIT modality than Wingate-based SIT.[8,9] Particularly, several SIT protocols with repeated short (≤10 s) efforts (sSIT) were shown to exhibit similar aerobic and anaerobic adaptations but better perceptual and enjoyment responses (i.e., "less pain, same gain") than Wingate-based SIT.[10–13] The greater efficiency of these sSIT protocols is related to the fact that the highest mechanical responses are achieved during the first seconds of sprinting bouts,[9] while the reduced glycolytic activity would result in less peripheral fatigue[14] because of the more reliance on the ATP-PCr pathway during the first 10 s of effort[15] Moreover, the acute responses of different sSIT schemes have been described with respect to physical,[10,14] physiological,[10,16,17] and perceptual[10,12] responses. However, there are only a few recent studies examining the physical and physiological adaptations after a number of sessions over only a few weeks, in cycling and running sprints with promising results.[18,19] Therefore, a systematic search of longitudinal studies including any sSIT protocol with both "all-out" and non-"all-out" efforts will aid in verifying the effectiveness of short efforts during different HIIT schemes for physical fitness development. This information is very important to elucidate the chronic adaptations of sSIT when compared to other HIIT/SIT and continuous training (CT) protocols, while expanding the understanding of the loading factors (e.g., intensity and work-to-rest ratio) associated with the more efficient adaptations after different sSIT schemes.

Thus, the aim of this systematic review with meta-analysis was to identify controlled (CTs) and randomized controlled trials (RCTs) that used very short efforts ≤10 s (8) over a minimum of 2 weeks, which is the minimum time required to induce stable adaptations (9), and to verify the effects of these training regimes on measures of aerobic and anaerobic fitness and performance. To avoid the confounding effect of training history (i.e., to be sedentary), age (maturational factors or aging), and clinical conditions (e.g., obese and cardiovascular disease), we decided to only include healthy physically active adults and athletes.

2 | METHODS

2.1 | Systematic literature search

A systematic literature search was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) and was previously registered with the international database of prospectively registered systematic reviews in health and social care (PROSPERO: CRD42020188226).

The databases PubMed/MEDLINE, ISI Web of Science, and SPORTDiscus were systematically searched using a search string that was specifically adapted to the search requirements for each database (see online Supplementary Table 1).

The search was conducted on May 9, 2020, and updated on September 14, 2021. The literature search process was performed independently by two researchers and included saving the online search, removing duplicates and screening titles, abstracts, and full texts. Possible conflicts were solved by consulting a third author. In addition, a gray literature search was performed by screening Google Scholar and the reference lists of previously identified eligible full texts. A flow chart of the search process and the study selection is displayed in Figure 1.

2.2 | Eligibility criteria

Inclusion criteria were defined based on the PICOS criteria.[20] The population included healthy young and

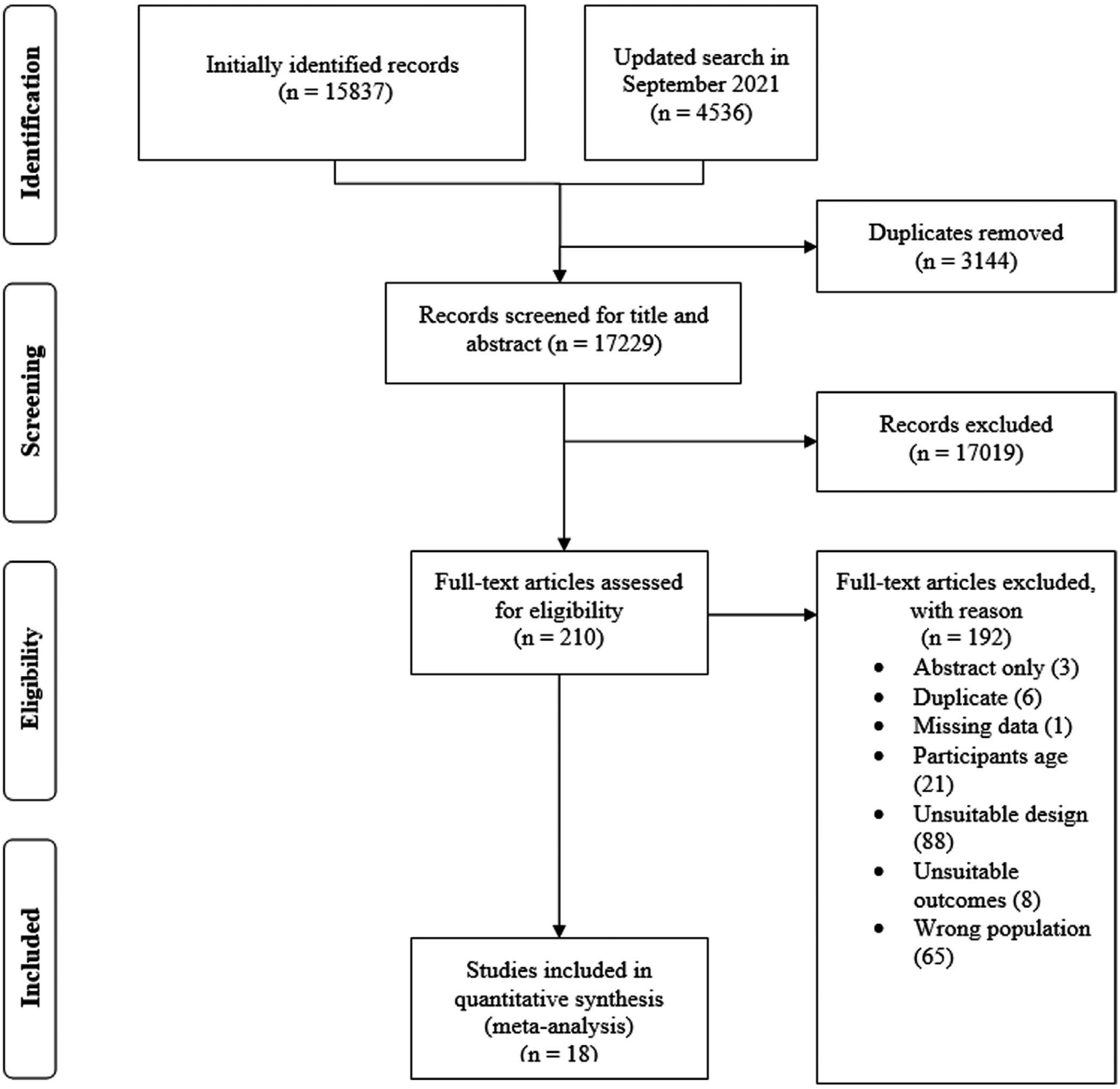

FIGURE 1 Flow chart of the search process and the study selection

middle-aged (18–40 years) athletes and active adults with no restrictions in terms of sex. The intervention had to be comprised of supervised sSIT of at least 2 weeks, with a minimum of 6 sessions. Only CTs and RCTs including a group performing sprints of ≤10 s of duration (or an equivalent distance-based [m] sprint) were included. As a comparator, eligible studies needed to include a non-sSIT control group (either no exercise or continuing their usual training without sSIT) or an endurance training group performing other exercise training regimens such as HIIT, SIT, or CT. The outcomes of interest were defined as aerobic capacity, aerobic performance, and anaerobic performance. For aerobic capacity, measures of peak ($\dot{V}O_2$peak) or maximal oxygen uptake ($\dot{V}O_2$max) were considered. Aerobic performance was defined as the maximal power achieved in a graded exercise test (Pmax), velocity associated with $\dot{V}O_2$max in graded exercise tests (v$\dot{V}O_2$max), completed time in graded exercise tests (GXT time), completed shuttles or distance in aerobic shuttle run tests, time trial performances, and the mean power output during a 3-minute all-out test (MPO). For anaerobic performance, derived measures of Wingate performance (peak power output [PPO]), sprint performance, repeated sprint performance (mean sprint time), and anaerobic shuttle run performance were considered. Exclusion criteria included language other than English and German, non-peer-reviewed articles, abstracts and thesis, cross-sectional studies assessing only acute exercise responses, and observational studies.

2.3 | Data extraction

Data extraction was performed independently by two authors. The following data were extracted from each included study: (1) the general characteristics (e.g., author(s), year of publication and aim of the study); (2) participants information (i.e., sample size, sex, training status, and age); (3) intervention data for all groups (i.e., intervention duration, types of interventions, and training loads); and (4) specific outcomes (e.g., measures of $\dot{V}O_2max$ and PPO). If the mean and standard deviation of the respective groups were not reported, authors of primary studies were contacted to provide baseline and postintervention data. In case data were presented within a graphic and no additional data were provided upon request, mean and standard deviation were extracted using WebPlotDigitizer (Pacifica, California, USA, Version: 4.4).[21]

2.4 | Data synthesis and analyses

Standardized mean differences (SMD) were calculated, and an inverse variance-weighted random-effects model was fitted to the effect sizes (ES). Meta-analyses were performed using R (3.6.2), RStudio (1.2.5033), and the metafor packages (version 2.4.0).[22] Effect sizes were calculated for *pre-test and post-test control group designs* using the raw score standardization recommended previously[23,24] Furthermore, exact sampling variance of the effect sizes was computed according to previous recommendations.[24]

Heterogeneity (i.e., τ^2) was estimated using the restricted maximum-likelihood estimator (REML).[25] In addition, in order to complete heterogeneity analyses, the Q-test for heterogeneity[26] and the I^2 statistic[27] were calculated. Studentized residuals and Cook's distances were examined to assess whether studies may be outliers and influential.[28] Studies with a studentized residual larger than the $100 \times (1–0.05 / (2 \times k))^{th}$ percentile of a standard normal distribution were declared potential outliers (i.e., using a Bonferroni correction with two-sided $\alpha = 0.05$ for k studies included in the meta-analyses). Studies with a Cook's distance larger than the median plus six times the interquartile range of the Cook's distances were considered influential. In case a study was identified as a potential outlier or overly influential, a sensitivity analysis was performed. A trim-and-fill-contour funnel plot was provided to estimate the number of studies potentially missing from the meta-analysis (Figure S1–S3). The rank correlation test[29] and the regression test,[30] using the standard error of the observed outcomes as predictor, were used to check for funnel plot asymmetry.

Effect sizes from studies with more than two intervention or control groups were combined in accordance with the recommendations of the Cochrane handbook.[31] In the case of multiple measurements for the same outcome, only one measure was included in the analysis. For aerobic performance, this was based on the following hierarchy: Pmax, $v\dot{V}O_2max$, GXT time, completed shuttles or distance in aerobic shuttle-run tests, time trial performance, and mean power output (MPO). For anaerobic performance, it was based on the following hierarchy: Wingate performance (PPO), repeated sprint performance (mean sprint time), sprint performance, and completed anaerobic shuttle runs.

When ≥3 studies were available, subgroup analyses were conducted for exercise intensity ("all-out" vs. non-"all-out"). For specific justification of exclusion of individual studies, please refer to the online Supplementary Table 2.

2.5 | Assessment of methodological quality

The risk-of-bias assessment for the included studies was carried out independently using the PEDro scale by two reviewers. The PEDro scale has previously been rated as a valid measure of the methodological quality of randomized trials.[32] Studies with scores >6 were considered to be of "high quality," studies with scores 4 – 5 were considered to be of "medium quality," and studies that scored less than 4 were considered to be of "low quality." The following sources of bias were considered: selection (sequence generation and allocation concealment), performance (blinding of participants/personnel), detection (blinding outcome assessors), attrition (incomplete outcome data), reporting (selective reporting), and other potential bias (e.g., recall bias). The risk-of-bias assessments for the included studies are shown in online Supplementary Table 3. The mean score for the PEDro scale criteria 2 – 11 was 3.8/10, that is, medium quality.

3 | RESULTS

3.1 | Study characteristics

The database search identified 15,837 potentially eligible articles in the initial search and 4,536 in the updated search. After further screening and eligibility assessment, a total of 18 studies were included in the final analyses (see Figure 1). The characteristics of studies, participants, and training interventions are summarized in online Supplementary Table 4. The meta-analysis included a total of 438 participants, of whom 239 performed supervised sSIT, 107 participants performed no exercise or no additional sSIT, 49 performed HIIT as control condition, 45 performed other SIT modality as control condition, and 13 performed CT as control condition. Of the included studies, cycling was the most common mode of exercise (8 studies),[13,19,33–38] followed by running (6 studies).[11,39–43] Additionally, boxing exercise,[44] canoe paddling,[45] functional fitness exercises,[46] handcycling,[47] and squatting + cycling[19] were also assessed by one study each. In 12 of the included studies, sSIT was performed at maximal possible intensity ("all-out"),[11,13,19,34,37,38,40,41,44–47] while 5 studies assessed the effect of non-"all-out" high-intensity efforts,[33,36,39,42,43] and one study gave no further description about the intensity.[35]

3.2 | $\dot{V}O_2$max

Twelve studies were included in the quantitative analysis of sSIT vs. no exercise or usual training. The SMD ranged from −2.12 to 0.33. The estimated SMD based on the random-effects model was −0.56 (95% CI: −0.79, −0.33, $p < 0.001$). The forest plot showing the observed outcomes and the estimate based on the random-effects model is shown in Figure 2. The Q-test revealed that the true outcomes are homogenous (Q(11) = 14.81, $p = 0.192$, $\tau^2 = 0.00$, $I^2 = 0.00\%$). The regression test indicated funnel plot asymmetry ($p = 0.046$) but not the rank correlation test ($p = 0.381$) (Figure S1A).

For the quantitative analysis of differences in $\dot{V}O_2$max of sSIT vs. HIIT/SIT/CT, eight studies were included in the final analysis. The SMD ranged from −0.64 to 0.39. The estimated SMD based on the random-effects model was 0.05 (95% CI: −0.19, 0.30, $p = 0.676$). The forest plot showing the observed outcomes and the estimate based on the random-effects model is shown in Figure 3. The Q-test revealed that the true outcomes are homogenous (Q(7) =4.700, $p = 0.696$, τ2 = 0.00, I2 = 0.00%). Neither the rank correlation nor the regression test indicated any funnel plot asymmetry ($p = 0.905$ and $p = 0.537$, respectively) (Figure S1B).

3.3 | Aerobic performance

Ten studies were included in the quantitative analysis of sSIT vs. no exercise or usual training. The SMD ranged from −1.24 to −0.04. The estimated SMD based on the random-effects model was −0.43 (95% CI: −0.67, −0.20, $p < 0.001$). The forest plot showing the observed outcomes and the estimate based on the random-effects model is shown in Figure 4. The Q-test revealed that the true outcomes are homogenous (Q(9) =9.44, $p = 0.398$, $\tau^2 = 0.00$, $I^2 = 0.00\%$). Neither the rank correlation nor the regression test indicated any funnel plot asymmetry ($p = 0.601$ and $p = 0.155$, respectively) (Figure S2A).

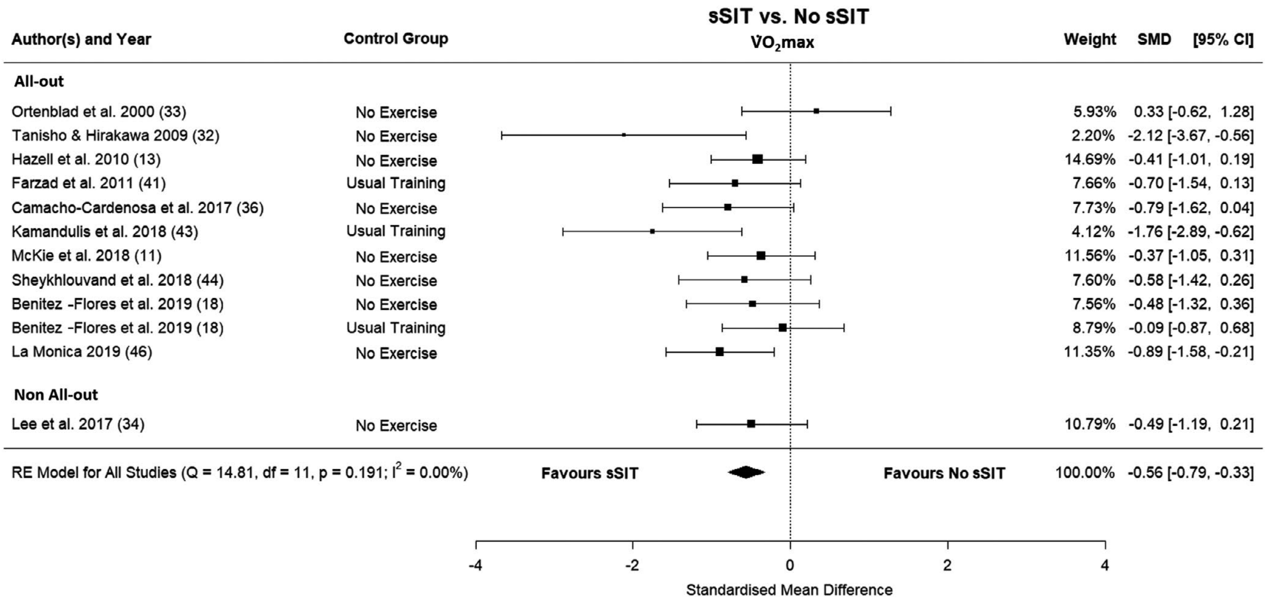

FIGURE 2 Forest plot showing the differences in effect sizes in $\dot{V}O_2$max of sSIT compared to no sSIT. CI, confidence interval; RE Model, random-effects model; SMD, standardized mean difference; sSIT, short sprint interval training; $\dot{V}O_2$max, maximal oxygen consumption

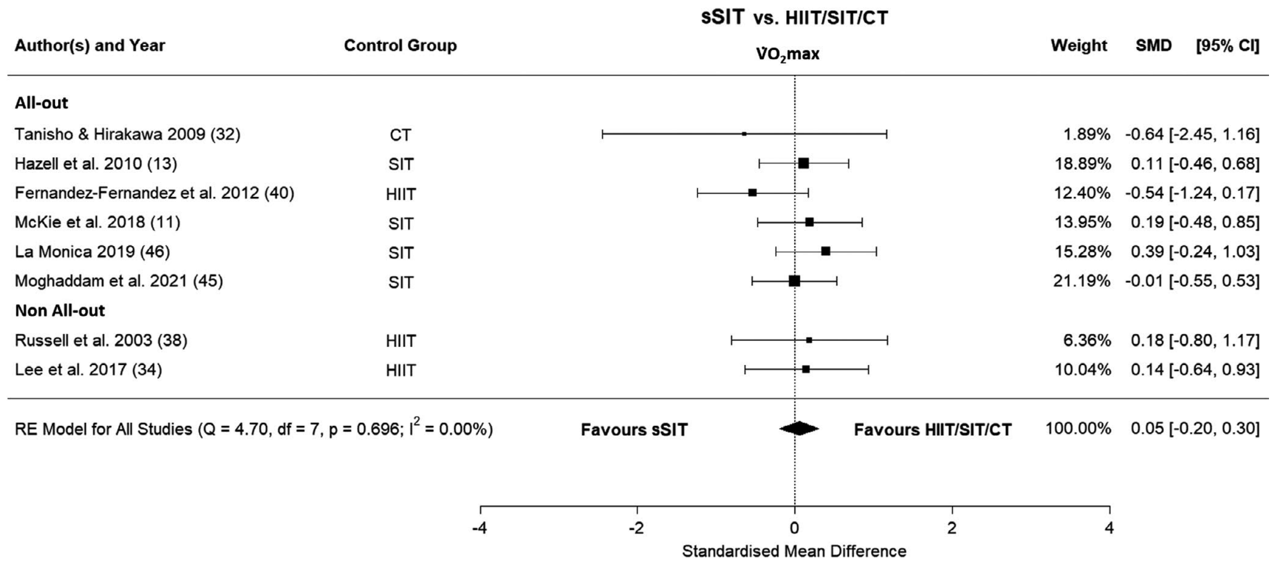

FIGURE 3 Forest plot showing the differences in effect sizes in $\dot{V}O_2$max of sSIT compared to HIIT/SIT/CT. CI, confidence interval; CT, continuous training; HIIT, high-intensity interval training; RE Model, random-effects model; SMD, standardized mean difference; sSIT, short sprint interval training; $\dot{V}O_2$max, maximal oxygen consumption

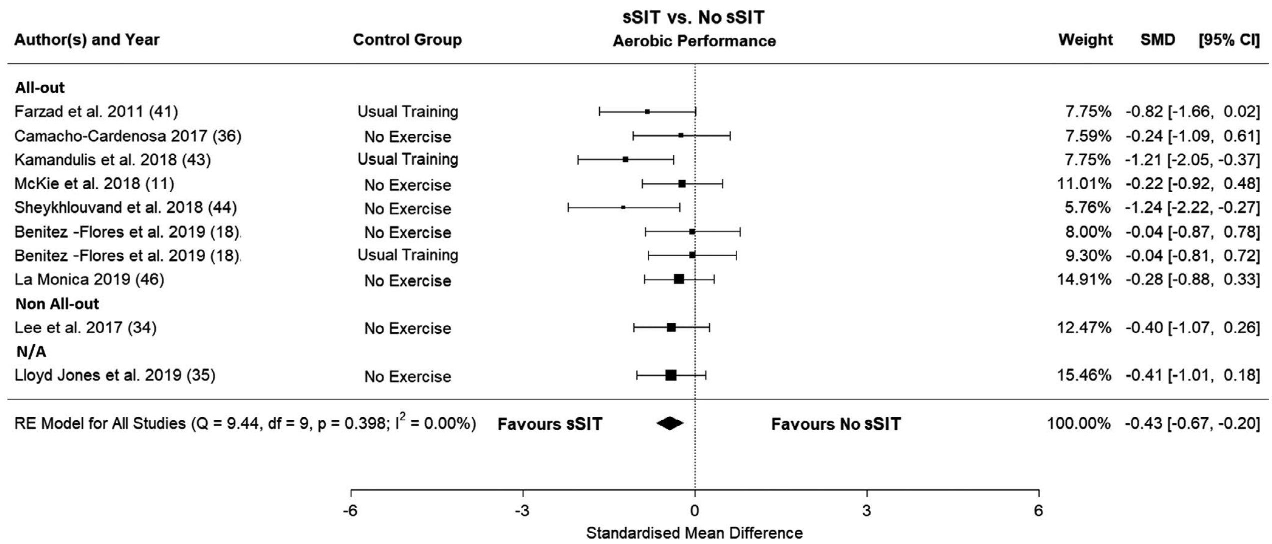

FIGURE 4 Forest plot showing the differences in effect sizes in aerobic performance of sSIT compared to no sSIT. CI, confidence interval; N/A, not available; RE Model, random-effects model; SMD, standardized mean difference; sSIT, short sprint interval training; $\dot{V}O_2$max, maximal oxygen consumption

For the quantitative analysis of differences in aerobic performance of sSIT vs. HIIT/SIT/CT, seven studies were included in the final analysis. The SMD ranged from −0.02 to 0.93. The estimated SMD based on the random-effects model was 0.15 (95% CI: −0.12, 0.42, $p = 0.281$). The forest plot showing the observed outcomes and the estimate based on the random-effects model is shown in Figure 5. The Q-test revealed that the true outcomes are homogenous ($Q(6) = 2.86$, $p = 0.826$, $\tau^2 = 0.00$, $I^2 = 0.00\%$). Neither the rank correlation nor the regression test indicated any funnel plot asymmetry ($p = 0.381$ and $p = 0.320$, respectively) (Figure S2B). The subgroup analysis revealed no statistical differences ($p > 0.05$).

3.4 | Anaerobic performance

Nine studies were included in the quantitative analysis of sSIT vs. no exercise or usual training. The SMD ranged from −1.73 to −0.07. The estimated SMD based on the

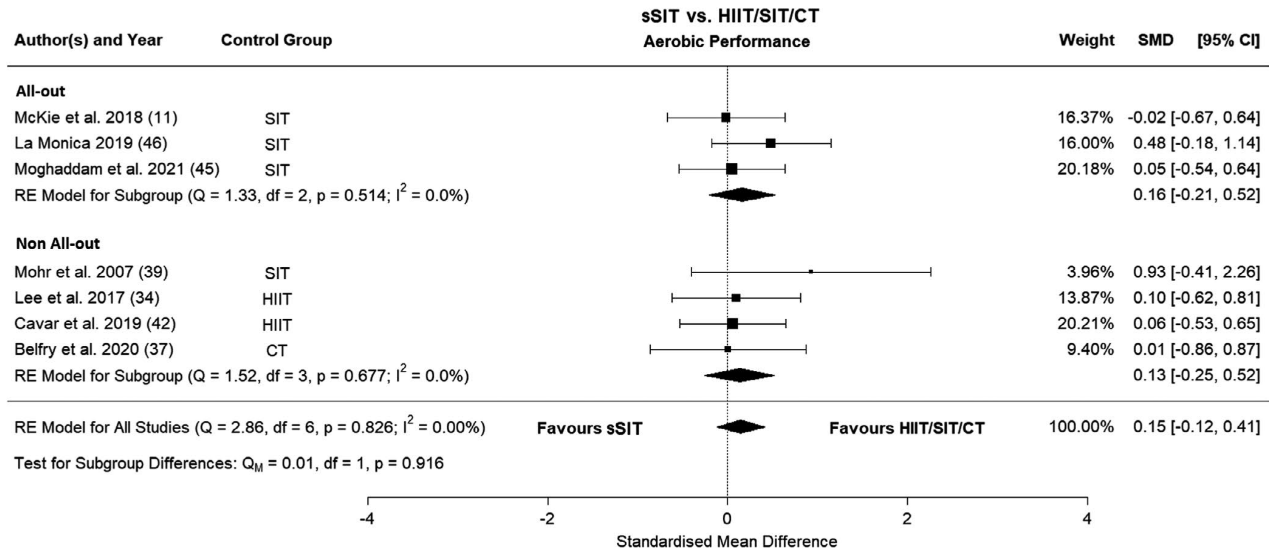

FIGURE 5 Forest plot showing the differences in effect sizes in aerobic performance of sSIT compared to HIIT/SIT/CT. CI, confidence interval; CT, continuous training; HIIT, high-intensity interval training; RE Model, random-effects model; SMD, standardized mean difference; sSIT, short sprint interval training; $\dot{V}O_2$max, maximal oxygen consumption

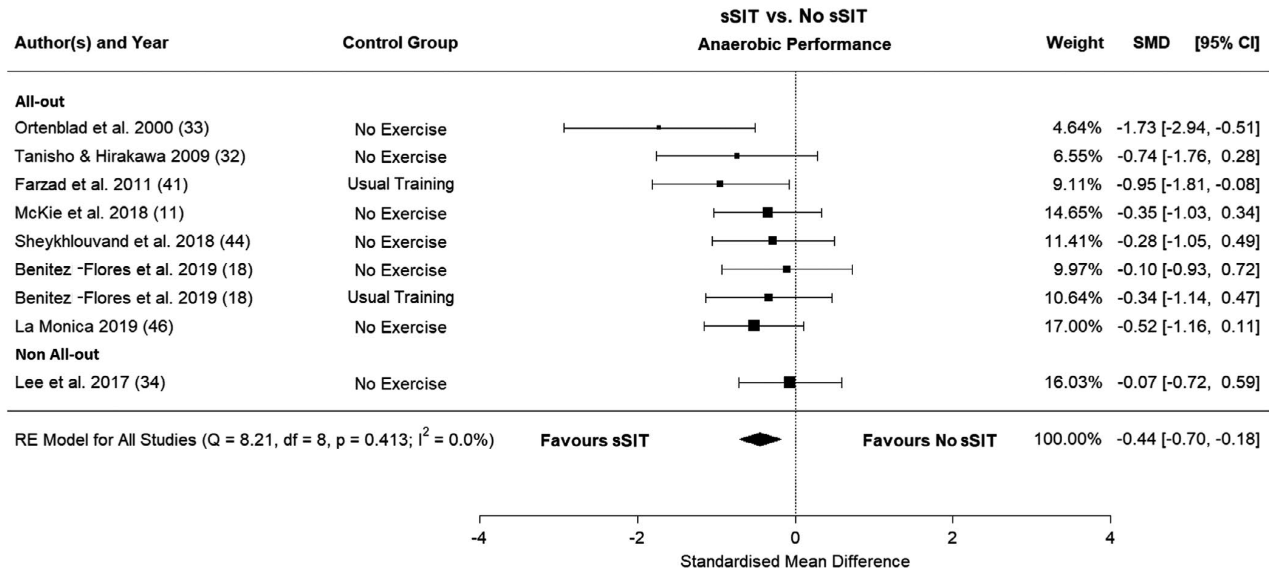

FIGURE 6 Forest plot showing the differences in effect sizes in anaerobic performance of sSIT compared to no sSIT. CI, confidence interval; RE Model, random-effects model; SMD, standardized mean difference; sSIT, short sprint interval training; $\dot{V}O_2$max, maximal oxygen consumption

random-effects model was −0.44 (95% CI: −0.70, −0.18, $p < 0.001$). The forest plot showing the observed outcomes and the estimate based on the random-effects model is shown in Figure 6. The Q-test revealed that the true outcomes are heterogeneous (Q(8) =8.21, $p = 0.413$, $\tau^2 = 0.00$ $I^2 = 0.00\%$). The regression test indicated funnel plot asymmetry ($p = 0.039$) but not the rank correlation test ($p = 0.119$) (Figure S3A).

For the quantitative analysis of differences in anaerobic performance of sSIT vs. HIIT/SIT/CT, eight studies were included in the final analysis. The SMD ranged from −0.64 to 0.74. The estimated SMD based on the random-effects model was 0.07 (95% CI: −0.25, 0.39, $p = 0.672$). The forest plot showing the observed outcomes and the estimate based on the random-effects model is shown in Figure 7. The Q-test revealed that the true outcomes appear to be homogenous, but some heterogeneity may still be present (Q(7) =10.76, $p = 0.149$, τ2 = 0.07, I2 = 35.32%). Neither the rank correlation nor the regression test indicated any funnel plot asymmetry ($p =$

0.548 and $p = 0.407$, respectively (Figure S3B). The subgroup analysis did not reveal a statistically significant difference ($p > 0.05$).

4 | DISCUSSION

This is the first meta-analysis evaluating the effects of sSIT (≤ 10-s sprints) on $\dot{V}O_2$max and measures of aerobic and anaerobic performances in different exercise modes in healthy adults and athletes. From the current results, it can be suggested that sSIT is an excellent means to develop $\dot{V}O_2$max and both aerobic and anaerobic performances in physically active individuals and athletes after short training periods of ≥2 weeks and that the effects of sSIT are similar to other continuous or HIIT/SIT protocols.

Our results confirm a high time efficiency of sSIT to increase $\dot{V}O_2$max in different populations after a short training period of ≥2 weeks, when compared to nonexercise or usual training regimens of physically active adults and athletes. Importantly, this effectiveness is similar to other more time-consuming endurance training methods including CT, HIIT, or traditional SIT in diverse populations (95% CI: −0.28, 0.26, $p = 0.951$). This finding further expands our current knowledge on the high effectiveness of low-volume traditional SIT to improve $\dot{V}O_2$max after only a few weeks of training.[8,9,48,49] Interestingly, the exercise modes used included punching,[44] paddling,[45] and functional fitness exercises,[46] apart from the more typically used cycling[13,19,33-38] and running.[11,39-43] Of note, although with a limited number of studies, it appears that non-"all-out" efforts may also be sufficient to induce significant improvements of $\dot{V}O_2$max after 4[36] and 6 weeks[43] of training. However, the lower intensity during non-"all-out" efforts was associated with a higher volume including 40 – 48 efforts during training.[36,43] Meanwhile, the other studies with "all-out" efforts only completed 6—36 efforts of diverse duration and work-to-rest ratios.[11,13,19,38,40,41,44-46] Therefore, while the high time efficiency (i.e., rapid $\dot{V}O_2$max improvements after a few sessions) of different protocols of sSIT has been confirmed, the most optimal dose response in terms of intensity (non-"all-out" vs. "all-out"), volume (number of sprints and sessions), and work-to-rest ratios in terms of $\dot{V}O_2$max improvements are yet to be defined.

Regarding aerobic performances, a number of sSIT protocols appeared to improve several performance parameters in studies using incremental[33,36,39,44,45] and time-trial tests,[11,40] while others did not find significant improvements.[34,42,47] Therefore, the positive effects of sSIT protocols on improving $\dot{V}O_2$max are accompanied by an increased endurance performance. However, the SMD was slightly greater for HIIT/SIT/CT protocols. Similar to $\dot{V}O_2$max improvements, the variety of protocols and exercise modes used limits our interpretation. In this regard, it is interesting to note that the most effective protocols for endurance performance enhancements involved athletes of different sports such as boxing,[44] wrestling,[40] and canoe polo,[45] who completed very short (3 – 6 s) "all-out" efforts with reduced recovery intervals (i.e., 10 s), totaling 12–36 repetitions per session. In addition, the included studies used different exercise modes than cycling and running, including punching,[44] paddling,[45] handcycling,[47] and functional exercises[46] with

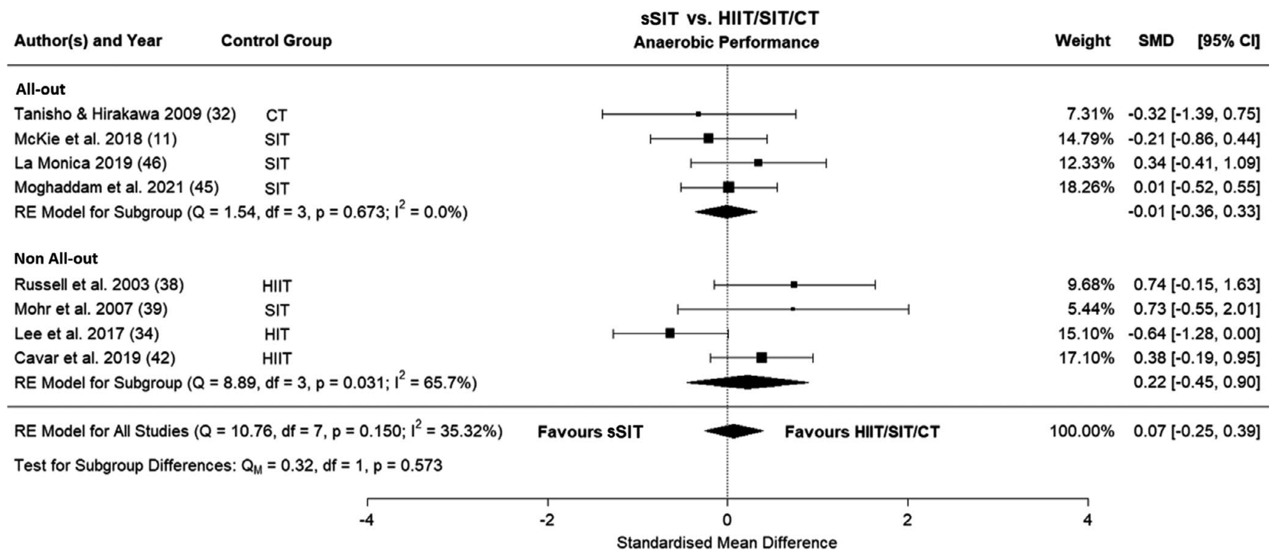

FIGURE 7 Forest plot showing the differences in effect sizes in anaerobic performance of sSIT compared to HIIT/SIT/CT. CI, confidence interval; CT, continuous training; HIIT, high-intensity interval training; RE Model, random-effects model; SMD, standardized mean difference; sSIT, short sprint interval training, $\dot{V}O_2$max, maximal oxygen consumption

diverse results. For instance, the study by La Monica et al.[47] included 2 and 4 minutes of recovery between the 10-s "all-out" hand cycling bouts and did not exhibit significant improvements in aerobic performance, thus reinforcing the need for short recovery intervals to favor aerobic adaptations. Therefore, it is suggested that the limited effectiveness of sSIT protocols to improve endurance performances may be more related to the duration of recovery intervals rather than to the exercise mode used and probably to the physical status of participants. Further studies should assess other protocol designs to simultaneously improve $\dot{V}O_2$max and endurance performances in different tests and populations with different training statuses.

As expected, from the current meta-analysis, it can be suggested that sSIT protocols are excellent means to improve anaerobic performances when compared to no exercise/usual training regimens. Furthermore, the differences with other HIIT/SIT protocols are negligible. Of note, these similar anaerobic performances between sSIT and HIIT/SIT protocols were evident, despite half (4/8) of the included mSIT studies were performed with non-"all-out" efforts.[36,39,42,43] Meanwhile, this high effectiveness for the enhancement of anaerobic performances reinforces the superiority of sSIT protocols when compared to traditional SIT protocols of longer sprints, as similar outcomes can be achieved with less effort in terms of psychological[50] and physiological[8] strains (i.e., "same gain with less pain"), probably as a result of the lower glycolytic activation.[19] As observed with $\dot{V}O_2$max and aerobic performance gains, the improvements in anaerobic performances also occurred after training with different exercise modes. Therefore, sSIT protocols can be confidently used to enhance anaerobic performances in different exercise modes.

4.1 | Strengths and limitations of the meta-analysis

As with the majority of other exercise science-related meta-analyses, the main limitation of the current systematic review with meta-analysis is the heterogeneity of studies with respect to sample characteristics and training history, exercise modes, loading parameters and protocols, and performance outcomes measures. However, with our inclusion criteria we have limited the sprints to both "all-out" and non-"all-out" efforts ≤10 s, independently of diverse HIIT and SIT definitions proposed by different authors, thus providing enough studies comparing sSIT to other training modalities, therefore, allowing a quantitative analysis of the selected outcomes.

4.2 | Perspective

This systematic review clearly shows the high efficiency of sSIT of "all-out" and non-"all-out" efforts to improve $\dot{V}O_2$max and both aerobic and anaerobic performances in different exercises. Therefore, for a better understanding of what factors are related to these performance enhancements, further comparisons should be made with different sSIT and HIIT/SIT protocols of equated loads but differing in sprint duration (4–10 s)[19] and work-to-rest ratios[36,47] in different exercise modes. In this regard, the combination of different exercises as in the concurrent training group (cycling +squatting) of the study by Benítez-Flores et al.[19] should be further explored. In addition, we only included healthy active adults and athletes; therefore, the applicability of sSIT protocols to other populations such as elderly people[51] and clinical populations[52] requires more research. Of note, to allow appropriate comparisons, further studies should better elaborate on participants' characteristics and training background to verify whether training status also affects performance outcomes. Furthermore, although non-"all-out" efforts seem to be also effective, the supposedly superiority of "all-out" efforts to optimize the dose-response and, thus, the efficiency of this training method for rapid physiological adaptations needs to be confirmed. Meanwhile, the use of non-"all-out" efforts prior to commencing with "all-out" efforts in a periodized fashion would seem an appropriate strategy for nonathletic populations. In this regard, attention should be paid to individual responses[53] to identify what factors are related to heterogeneity in these responses.

5 | CONCLUSIONS

Our data suggest the effectiveness of sSIT protocols comprised of exercise bouts of ≤10 s, to enhance both $\dot{V}O_2$max and aerobic and anaerobic performances, making sSIT a powerful time-efficient means to enhance physical fitness and performance within only few weeks and with a reduced exercise dose. Importantly, this effectiveness has been proven in different exercise modes such as cycling and running, as well as sport-specific exercises such as paddling and punching. Further studies should elaborate on the loading parameters and rest periods associated with optimal adaptations in diverse populations.

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DATA AVAILABILITY STATEMENT

The data that supports the findings of this study are available in the supplementary material of this article.

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Extremely Low-Volume Burpee Interval Training Equivalent to 8 Minutes Per Session Improves Vertical Jump Compared with Sprint Interval Training in Real-World Circumstances

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Original Research

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Extremely Low-Volume Burpee Interval Training Equivalent to 8 Minutes Per Session Improves Vertical Jump Compared with Sprint Interval Training in Real-World Circumstances

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[1]*Department of Physical Education and Health, Higher Institute of Physical Education, University of the Republic, Montevideo, Uruguay;* [2]*Aquatic Sports Research Group, School of Physical Education, Physiotherapy and Dance, Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil; and* [3]*Department of Kinesiology, California State University San Marcos, San Marcos, California*

Abstract

Pérez-Ifrán, P, Magallanes, CA, de S. Castro, FA, Astorino, TA, and Benítez-Flores, S. Extremely low-volume burpee interval training equivalent to 8 minutes per session improves vertical jump compared with sprint interval training in real-world circumstances. *J Strength Cond Res* XX(X): 000–000, 2023—The aim of this study was to compare the cardiometabolic and physical effects of 2 time-matched high-intensity programs in a real-world environment. Forty-three active and healthy adults (sex = 31 men and 12 women; age = 27 ± 5 years; peak heart rate [HR_{peak}] = 190.7 ± 10.6 beat·min^{-1}) were randomized to 2 very low-volume protocols (~8 minutes): sprint interval training (SIT) (n = 15), burpee interval training (BIT) (n = 15), and control (CON) (n = 13). Subjects in SIT and BIT performed 5 days of 10 × 4 second "all-out" efforts with 30 seconds of recovery. Body composition, blood pressure, countermovement jump (CMJ), 10-m sprint, shuttle run test (SRT), autonomic modulation, self-efficacy, and intention were evaluated before and after training. Sprint interval training elicited a higher %HR_{peak}, energy expenditure, rating of perceived exertion category ratio 10 scale, and feeling scale than BIT ($p < 0.05$). $SRT_{distance}$ was significantly improved in SIT ($p = 0.03$, $d = 0.62$), whereas CMJ height was significantly enhanced in BIT ($p = 0.0014$, $d = 0.72$). Self-efficacy progressively worsened for SIT than for BIT as sessions increased, and significant differences were found in 5× a week frequency between protocols ($p = 0.040$, $d = 0.79$). No differences in intention to engage were detected between the regimens ($p > 0.05$). No changes were observed in body composition, blood pressure, 10-m sprint, SRT$\dot{V}O_{2max}$, or autonomic variables with training ($p > 0.05$). Results exhibit that extremely low-volume SIT improved running performance, whereas BIT increased the vertical jump.

Key Words: high-intensity interval training, high-intensity functional training, exercise prescription, cardiometabolic health, cardiovascular adaptations

Introduction

The prevalence of physical inactivity is a critical public health problem because currently, 7.2 and 7.6% of all-cause and cardiovascular deaths, respectively, are attributable to sedentary behavior (20). Moreover, physical inactivity dramatically reduces the quality of life and promotes disability and premature death because of its association with several noncommunicable diseases, including type 2 diabetes, hypertension, coronary heart disease, and several cancers (20). Paradoxically, obese individuals who are physically active and metabolically healthy (i.e., they have a high aerobic fitness i.e., maximum oxygen consumption [$\dot{V}O_{2max}$]) have a 30–50% lower risk of mortality from cardiovascular disease than obese adults with lower $\dot{V}O_{2max}$ (24). Maximum oxygen consumption is a significant predictor of the risk of all-cause mortality because an improvement equal to 3.5 ml·kg^{-1}·min^{-1} is associated with a 13 and 15% lower risk of all-cause mortality and cardiovascular events, respectively (21). In addition, a slow heart rate recovery (HRR) after exercise is established as an independent predictor of mortality (10), and heart rate variability (HRV) is inversely associated with all-cause mortality (22). Therefore, high $\dot{V}O_{2max}$ and high HR variability may mitigate the deleterious health consequences of sedentary lifestyle.

Current physical activity (PA) guidelines recommend 150–300 min wk^{-1} of moderate-intensity continuous training or 75–150 min wk^{-1} of vigorous-intensity PA to improve health status (8). However, these recommendations are not met by most adults as a large portion of the population is insufficiently active (8). Frequently, individuals report not having sufficient time to engage in PA (45), and thus, many clinicians have called for implementing more time-efficient PA programs. It is well documented that low-volume interval training promotes various physiological adaptations, including clinical (i.e., glycemic control, redox status, blood pressure, cardiac output, etc.) (2,5,40,46) and physical (i.e., $\dot{V}O_{2max}$, time trial performance, peak power output, etc.) (2,5,6,46) parameters in healthy and unhealthy adults. Interval training can be implemented using repeated submaximal efforts (high-intensity interval training [HIIT] at ≥80 of maximal HR) or "all-out" efforts (sprint interval training [SIT] at a power output ≥100% of the workload associated with $\dot{V}O_{2max}$) (40).

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Sprint interval training has been identified as a very robust method to improve outcomes related to aerobic and anaerobic metabolism (41). Nevertheless, Wingate-based SIT is impractical for nonathletic adults because it elicits severe fatigue, hyperventilation, and nausea. Nevertheless, low-volume SIT characterized by a short-interval duration (i.e., 5 seconds) and fewer number of intervals have been proposed to reduce neuromuscular fatigue and enhance contribution of oxidative metabolism while improving subject tolerance (4). Despite the attenuated volume, short sprints have been shown to induce physiological adaptations, including significant improvements in $\dot{V}O_{2max}$ and peak power output (6), in healthy adults and athletes. In addition, low-volume SIT has been shown to be effective in diabetic, prehypertensive, and obese patients in reducing the risk of cardiometabolic disease (46). Although experimental data clearly support the efficacy of low-volume SIT, the effectiveness of this approach under "real-world" conditions is controversial (46). Therefore, new studies are needed to investigate the effects of low-volume SIT with short bouts in real-world situations and potentially elucidate the best dose-response relationship to elicit physiological adaptations.

High-intensity functional training (HIFT) is a popular alternative to laboratory-based interval training because it does not require equipment and can be performed in a small space. These exercises are performed with body mass (i.e., burpees, mountain climbers, jumping jacks, etc.) and can be implemented in public environments such as parks, beaches, or sports courts. Chronic HIFT significantly enhances neuromuscular and cardiorespiratory function in clinical and healthy populations (39). For example, extremely low-volume (~8 minutes) HIFT significantly increases $\dot{V}O_{2max}$ and time to exhaustion (29,38), muscle endurance, and power (29,38) and promotes beneficial changes in body fat and lean mass (25) in healthy adults. However, a recent meta-analysis summarizing 19 studies showed no changes in cardiometabolic variables (i.e., blood pressure, fasting glucose, or lipid profile) after 4–20 weeks of HIFT (39). Furthermore, HIFT exhibited lower increases in cardiorespiratory fitness yet greater changes in neuromuscular responses than traditional aerobic exercise (39). Nevertheless, to our knowledge, no study has compared chronic responses between HIFT vs. SIT, and only 2 studies compared the acute response to each regimen (3,14). In addition, the effects of HIFT, including short "all-out" bouts on cardiorespiratory fitness and neuromuscular performance, have yet to be explored.

The purpose of this study was to compare cardiometabolic and neuromuscular adaptations to 3 weeks of field-based HIFT and SIT with identical training volume. Developing exercise protocols in real-world scenarios is crucial to improve PA adherence and bridge the gap between laboratory and field exercise prescription. We hypothesize that very low-volume HIFT will attenuate cardiorespiratory adaptations but promote greater neuromuscular effects than SIT.

Methods

Experimental Approach to the Problem

To test the study's hypothesis, we adopted a randomized controlled design including 2 experimental groups and a nontraining control group (CON). All groups performed 2 testing sessions (pre and post), and the experimental groups completed 5 very low-volume training sessions (~8 minutes) during a 3-week period. Previously, it was shown that 6 low-volume sessions of short (i.e., 5 seconds) SIT improve cardiometabolic outcomes in young adults (5), although any effect of SIT having fewer sessions is unknown. Each training session was separated by 48–72 hours of recovery. This design was developed with the aim of being ecologically valid, using low-cost tools that are easy to use. Training was performed on an indoor basketball court with constant environmental conditions. All procedures were performed by the same evaluators, and to avoid effects of the circadian cycle, all sessions were held at the same time of day (8:00–12:00 PM). The incidental PA and dietary intake were monitored throughout the experiment.

Subjects

Initially, 87 individuals contacted the primary investigator after a publicity campaign at the University of the Republic, and 55 were recruited to participate in this study. From this sample, 50 volunteers met the inclusion criteria and were subsequently enrolled in the study. The inclusion criteria were as follows: (a) being moderately physically active (≥600 MET•min wk^{-1}) according to the International Physical Activity Questionnaire (IPAQ) Spanish short version (34), (b) not consuming any nutritional supplement, drugs, or tobacco products, (c) free of risk factors associated with cardiometabolic diseases, any musculoskeletal injury, and COVID diagnosis, (d) not using any beta-blockers drugs, (e) age between 18 and 40 years, and (f) if they were women, not be pregnant, or lactating. Subsequently, the subjects were randomly allocated into 3 groups and 43 completed the study: sex = 31 men and 12 women; age = 27 ± 5 years; height = 170.6 ± 8.9 cm; peak heart rate (HR_{peak}) = 190.7 ± 10.6 beat·min^{-1}; SIT; n = 15; burpee interval training (BIT); n = 15; and CON; n = 13. Seven subjects dropped out of the study for several reasons (Figure 1). The subjects were instructed to maintain their incidental lifestyle (work, hours of sleep, etc.) during the experiment, abstain from consuming alcohol for 48 hours before each session, and to avoid consumption of stimulants (mate, coffee, etc.) in the mornings. They were asked to wear loose clothing, be euhydrated, and not cycle or walk to the court before each test. Before their participation, the experimental procedures, benefits, and potential risks were explained to all subjects in written and verbal forms, and subsequently, they provided written informed consent. This study was approved by the University Ethics Committee of the Higher Institute of Physical Education, University of the Republic Uruguay (No. 2/2020 and date of final approval November 4, 2020) and was conducted following the principles stipulated in the Declaration of Helsinki (https://sites.jamanetwork.com/research-ethics/index.html).

Procedures

Testing Measures. Informed consent and various questionnaires were completed at the beginning of the first day, and subsequently, the subjects performed all assessments in the following sequence: (a) body composition, (b) blood pressure, (c) familiarization, (d) vertical jump, (e) 10-m sprint, and (f) shuttle run test (SRT, Figure 1). Exercise training included 5 sessions for each group, composed of 10 "all-out" bouts of 4-second duration with 30 seconds of recovery. This protocol was used in a previous acute study (3) and was included in a meta-analysis showing significant aerobic and anaerobic adaptations in response to SIT (6). The training intensity was monitored during each session using physiological and psychological outcomes. These tests were repeated at least 72 hours after the final session of training.

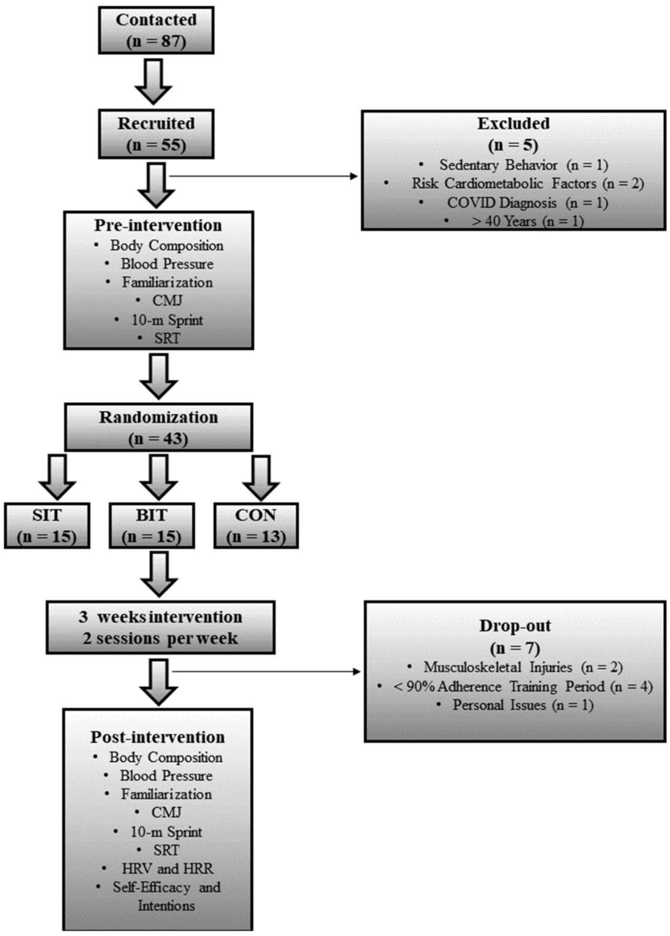

Figure 1. Study design. SIT = sprint interval training; BIT = burpees interval training; CON = control; CMJ = countermovement jump; SRT = shuttle run test; HRV = heart rate variability; HRR = heart rate recovery.

Body Composition We measured height (in centimeters) using a stadiometer (2096 PP; Toledo do Brazil, Sao Paulo, Brazil) and body mass (in kilograms), body mass index (BMI), muscle mass (%), fat mass (%), and visceral fat mass (%) using a digital body composition monitor (HBF 514C; OMRON, Kyoto, Japan). The measures were determined following previous procedures (32). To measure waist circumference (WC), the subjects assumed a relaxed standing position with the arms folded across the thorax, and WC was recorded at the level of the narrowest point between the lower costal (rib) border and the top of the iliac crest, at the end of normal expiration (32). Hip circumference (HC) was assessed at the level of the greatest posterior protuberance of the buttocks and perpendicular to the long axis of the trunk (32). Two measurements were taken with an anthropometric tape (SN-4010; Sanny Medical Starret, Sao Paulo, Brazil), using the mean value for analysis. The waist-to-hip ratio (WHR) was calculated by dividing WC and HC.

Blood Pressure Blood pressure was measured in a sitting position after 3 minutes of rest using a digital sphygmomanometer (CH-432; CITIZEN, Tokyo, Japan). This monitor has been shown to be reliable and valid to monitor blood pressure (11). The subject was seated with the arm slightly bent, the palm facing up, and the forearm supported nearly horizontal at the level of the heart. In addition, the arm was free of tight clothing that could partially occlude blood flow (16). During the test, the legs were not crossed, and any form of isometric muscle action was to be avoided, such as pressing the legs down, hanging the feet off the ground, or sitting upright with the back unsupported. We positioned the cuff on the right arm with the lower margin about 2.5 cm above the antecubital space. Throughout the measurement, the arm was extended and supported at the level of the heart (16). Two measurements were performed following these procedures with a 3-minute rest interval between the assessments, and the mean value for diastolic blood pressure (DBP) and systolic blood pressure (SBP) was used for analysis.

Familiarization All subjects performed a 3-minute warm-up of running at a self-selected pace. Then, the subjects were familiarized with vertical jump and burpees. Initially, 2 repetitions of the countermovement jump (CMJ) were completed. The subjects were instructed to rest their hands on their hips while performing a downward movement to approximately 90° of knee flexion, followed by a maximal vertical jump, keeping their legs straight during the flight phase and landing at the same take-off point (26). Familiarization with the burpees was performed according to Gist et al. (14). The subjects stood with arms at the sides, then lowered into a squat position and placed the hands on the ground in front of the feet, then kicked the feet back and initiated a push-up, returned to a squat position, and ended with a maximal jump with arms extended overhead. Approximately 5 minutes later, subjects were familiarized with SIT, which also served to provide practice for the 10-m sprint.

Countermovement Jump The CMJ is a validated and accessible method to determine lower-body power (26). The CMJ (CMJ_{height}) and absolute and relative body mass CMJ peak power ($CMJ_{powerabs}$, $CMJ_{powerrel}$) were recorded with PUSH band version 2.0 (PUSH Inc., Toronto, ON, Canada), which is valid and reliable for vertical jumps (30). The device was securely placed on the lower back with a waist belt. The average of 2 repetitions separated by 1 minute of passive recovery was analyzed.

10-m Sprint The 10-m sprint time was assessed, including 5-m split time. The subjects were instructed to run at maximum speed over a distance of 10 m, starting with the front foot 50 cm behind the starting line. Two repetitions were completed separated by passive recovery of 1 minute. Time to cover 10 m was recorded with *MySprint app* (Apple Inc., Cupertino, CA) that showed adequate validity and reliability for sprint time (35). *MySprint* was used with iPad (Apple Inc., Cupertino, CA) and was located 10 m away on a tripod, following the recommendations for measurements suggested by the creators of the APP (35). The mean of the 2 attempts was used for the analysis.

Shuttle Run Test The SRT is considered a valid approach to estimate $\dot{V}O_{2max}$ (43). The test consists of running for as long as possible between 2 lines separated by 20 m with a rhythm imposed by audio. The test starts with an initial speed equivalent to 8.5 $km \cdot h^{-1}$ and has increments equal to 0.5 $km \cdot h^{-1}$ every minute. The end of the test is determined when the 20-m distance cannot be covered in 2 consecutive efforts. To estimate $\dot{V}O_{2max}$, the equation proposed by Stickland et al. (43) was used: Men $\dot{V}O_{2max} = 2.75 \times$ [last half-stage complete] + 28.8; Women $\dot{V}O_{2max} = 2.85 \times$ [last half-stage complete] + 25.1). Also, HR_{peak} was recorded by employing chest straps through a telemetric system (Firstbeat Sports software version 4.7.3.1; Firstbeat Technologies Ltd., Jyväskylä, Finland). All subjects were verbally encouraged to exercise to exhaustion, and we used 2 criteria to classify the effort as maximum: (a) peak HR ≥90% of the age-predicted maximum (208 − [0.7 × age]); and (b) visible exhaustion. All subjects were verbally encouraged to exercise to exhaustion.

Dietary Intake During the training period, subjects tracked their dietary intake for 2 random days including 1 week day and 1 weekend day. A dietician instructed subjects how to complete the food diary and analyzed the information concerning total kcals, % carbohydrates, % proteins, and % fats. These data were analyzed using a custom-software MyFitnessPal (MyFitnessPal, Inc., San Francisco, CA) (44).

Incidental Physical Activity The incidental PA was assessed in all groups using IPAQ Spanish short version. This questionnaire was applied on the first and the last day of training to assess the PA done during the last week. It has adequate validity to quantify PA levels in young adults in contrast to accelerometry (34). The variables compared included (a) $Kcal \cdot wk^{-1}{}_{total}$; (b) $Kcal \cdot wk^{-1}{}_{vigorous}$; (c) $Kcal \cdot wk^{-1}{}_{moderate}$; and (d) $Kcal \cdot wk^{-1}{}_{walking}$.

Intervention Group Measures.

Interval Training Sessions Initially, subjects ran for 3 minutes at a self-selected pace. Total duration of each session was 5 minutes 10 seconds, and total exercise time was 40 seconds. Sprint interval training and BIT were equal in relation to the type of effort ("all-out"), type of stimulus (multijoint), and work-to-recovery ratio. Passive recovery was accomplished for both interventions, given that this type of rest was well tolerated across running-based SIT and BIT (28). During SIT, subjects were instructed to run as fast as they could, and after recovery, subjects were asked to run in the opposite direction. During BIT, subjects were encouraged to perform as many repetitions per interval as possible while maintaining correct technique. Burpees are a widely used exercise within HIFT routines; however, their unique longitudinal effects have not yet been revealed (39). Both regimens were monitored by a mobile application that provides audible alerts for each series (10 × 4-second work and 30 seconds of recovery). Heart rate data were collected with a telemetric system (Firstbeat Sports software version 4.7.3.1; Firstbeat Technologies Ltd., Jyväskylä, Finland) that is valid and reliable (33), to describe internal load represented as the HR_{mean} and percentage of heart rate peak ($\%HR_{peak}$). Also, rating of perceived exertion category ratio 10 scale (CR-10 RPE) was used because it is designed to estimate the intensity of exercise, and it strongly correlated with HR (13). This instrument is graduated numerically from 0 to 10, with 0–2 ratings deemed easy effort, 3–6 ratings moderate to hard effort, and 7–10 ratings hard to maximum effort (13). This scale shows validity and good reliability for men and women (15). In addition, the feeling scale (FS), a psychometric tool that describes affective valence and emotional aspects of the exercise experience, focusing on the pleasure-displeasure dichotomy (17) was used to assess affective valence. This scale was validated in physically active individuals (1). The FS contains values from +5 to −5 (+5 equal "very good" and −5 represents "very bad"). Both scales were recorded immediately post-exercise. The physiological and psychological outcomes were recorded during the first, second, fourth, and fifth training sessions. Throughout the sessions, the researchers provided strong verbal encouragement for subjects to achieve maximum effort in each interval.

Heart Rate Variability and Heart Rate Recovery To assess the impact of the exercise protocols on autonomic balance, we analyzed the response of the HRV and HRR. Subjects remained in a supine position, which showed more reliability than other positions (7), and completed 2-minute records pre and post exercise in session first, second, fourth, fifth. They were requested to breathe normally and avoid any movements throughout data acquisition. To assess HRV, we analyzed only the second minute of recording (baseline and end for each session) because the first minute is considered a stabilization period during resting. This approach can assess autonomic function accurately in field environments and is easily applied during training routine (12). The variables selected were the R-R intervals and the root mean square of successive differences between R-R intervals (RMSSD), which is recognized as the strongest indicator of parasympathetic modulation (7). In addition, this parameter is not influenced by breathing frequency and can measure parasympathetic tone in a short period (7). Furthermore, the HRR was evaluated and defined as the difference between HR at the end of exercise (HR_{end}) and after 60 and 120 seconds of recovery ($\Delta HR_{end\text{-}60s\ end}$, $\Delta HR_{end\text{-}120s\ end}$). Also, we assessed the differences between baseline HR (HR_{bas}), and HR_{end} ($\Delta HR_{bas\text{-}end}$), 60 and 120 seconds ($\Delta HR_{bas\text{-}60s\ end}$, $\Delta HR_{bas\text{-}120s\ end}$).

Exercise Task Self-Efficacy and Intentions After the last training session, subjects' confidence to repeat the exercise protocol completed at different frequency per week (i.e., 1× a week to 5× a week) was assessed using a 5-item scale (19). Each question included the stem, "How confident are you that you can…". The 5-items were as follows: (a) "perform one bout of exercise a week for the next 4 weeks that is just like the one you completed today?"; (b) "perform two bouts of exercise a week for the next 4 weeks that is just like the one you completed today?"; (c) "perform three bouts of exercise a week for the next 4 weeks that is just like the one you completed today?"; (d) "perform four bouts of exercise a week for the next 4 weeks that is just like the one you completed today?"; (e) "perform five bouts of exercise a week for the next 4 weeks that is just like the one you completed today?". Responses were scored on a scale of 0% (not at all) to 100% (extremely confident) in 10% increments. Previously, the instrument demonstrated good internal consistency (α's > 0.95) (19). Moreover, we asked the subjects regarding their ability to repeat the exercise using a 5-item measure, and the subjects' intentions to engage in the training regimens performed in the future at rates of 3 times or 5 times a week (intention 3× a week or intention 5× a week) over the next month (19). Specifically, subjects were asked "Please rate the extent to which you agree with the following statements": (a) "I intend to engage in the type of exercise I performed today at least 3 times per week during the next month", (b) "I intend to engage in the type of exercise I performed today at least 5 times per week during the next month." The scores were registered using a Likert-type 7-point scale, ranging from 1 (very unlikely) to 7 (very probable).

Statistical Analysis

A priori power analysis through G*Power 3.1.9.7 (Dusseldorf University, Dusseldorf, Germany) was used to determine the required sample size to detect a change in $\dot{V}O_{2max}$, considering the following input parameters: repeated-measures analysis of variance (ANOVA; within-between interaction), effect size $f = 0.25$; $\alpha = 0.05$; statistical power = 0.80, 3 groups, 4 measurements, correlation among repeated measures 0.4. The required sample size was 12 in each group, which was met in this study.

Descriptive statistics (mean ± *SD* and lower and upper limits—95%—of the confidence intervals) were calculated. Data normality was not tested because ANOVA is robust to normality infractions (36). Otherwise, when Student's t tests were applied, data normality was verified with Shapiro-Wilk test. To verify test reliability, intraclass correlation coefficients (ICC, 2-way mixed model for consistency analysis) were applied for WC, HC, SBP, DPB, $CMJ_{powerabs}$, $CMJ_{powerrel}$, and 5- and 10-m sprint time. To compare the baseline parameters between SIT, BIT, and CON, and dietary intake across SIT, BIT, and CON, 1-way ANOVA was applied. The Levene's test and the post hoc test (Bonferroni's if Levene's test result >0.05 and Tamhane's if Levene's test result <0.05) were executed.

To compare incidental PA, cardiometabolic, and physical parameters among SIT, BIT, and CON, a mixed, repeated-measures, 2 × 3 ANOVA (time and groups) was applied. To compare perceptual and heart rate response during training between SIT and BIT, a mixed, repeated-measures, 4 × 2 ANOVA (sessions and groups) was applied. To compare intentions between SIT and BIT, we used a mixed, repeated-measures, 2 × 2 ANOVA (intentions and groups). To compare self-efficacy between SIT and BIT groups, a mixed, repeated-measures, 5 × 2 ANOVA (bouts of exercise and groups) was applied. In all factorial ANOVAs, the main effects (with Bonferroni's post hoc test, when necessary) and interaction between factors were analyzed. When interactions were significant, splits were performed (1-way ANOVA, with Bonferroni's post hoc test, when necessary, and Student's *t* test for dependent data). In all repeated and factorial ANOVAs, Mauchly's test identified the sphericity. When sphericity was not assumed, the Greenhouse-Geisser Epsilon correction was used. Training response, between SIT and BIT, was compared with independent *t* test.

To verify the effects sizes, partial eta-squared (η^2) and Cohen' *d* tests were performed. Interpretation of η^2 indicates small ($\eta^2 \geq 0.02$), medium ($\eta^2 \geq 0.13$), or large ($\eta^2 \geq 0.26$) effect sizes for a 2-way ANOVA and small ($\eta^2 \geq 0.01$), medium ($\eta^2 \geq 0.06$), or large ($\eta^2 \geq 0.14$) effect sizes for 1-way ANOVA. Interpretation of Cohen's *d* indicates 0–0.19 trivial, 0.2–0.59 small, 0.6–1.19 moderate, 1.2–1.99 large, 2.0–3.99 very large, and >4.0 nearly perfect (9). The overall alpha level was set at $p < 0.05$. However, in the ANOVAs, the significance level was corrected for the number of comparisons, using the Bonferroni's correction factor. All analyses were performed with IBM SPSS version 23.0 (Armonk, NY).

Results

Reliability

Intraclass correlation coefficients were equal to 0.99, 0.86, 0.86, 0.86, 0.98, 0.96, 0.95, and 0.98, respectively, for WC, HC, SBP, DPB, $CMJ_{powerabs}$, $CMJ_{powerrel}$, and 5- and 10-m sprint time (all $p < 0.001$).

Dietary Intake and Incidental Physical Activity in All Groups

Total energy intake was equal to 1,252.0 ± 414.5 [816.9–1,687.0], 1,244.3 ± 466.3 [986.0–1,502.6], and 1,133.0 ± 276.3 [966.0–1,300.0] kcal for SIT, BIT, and CON, respectively ($F = 0.33$, $p = 0.71$, $\eta^2 = 0.02$). Carbohydrate intake was equal 48.2 ± 9.7 [42.8–53.6], 48.0 ± 6.5 [44.4–51.6], and 45.2 ± 8.4 [40.0–50.3] % for SIT, BIT, and CON, respectively ($F = 0.55$, $p = 0.57$, $\eta^2 = 0.002$) Fat intake did not differ across the 3 groups was 18.2 ± 4.0 [16.0–20.4], 17.8 ± 2.8 [16.3–19.4], and 17.6 ± 3.1 [15.7–19.6] % for SIT, BIT, and CON ($F = 0.087$, $p = 0.91$, $\eta^2 = 0.004$). Protein intake was not significantly different among groups: 32.0 ± 9.5 [26.7–37.3], 34.0 ± 5.9 [30.8–37.5], and 35.5 ± 9.9 [29.5–41.5] % for SIT, BIT, and CON ($F = 0.58$, $p = 0.56$, $\eta^2 = 0.02$).

No time × group interaction was detected for total PA kcals ($F = 0.33$, $p = 0.71$, $\eta^2 = 0.021$): pre-SIT 3,993.6 ± 3,046.3 [2,306.6–5,680.7] and post-SIT 2,680.1 ± 2,065.9 [512.0–4,848.1], pre-BIT 5,111.3 ± 3,053.9 [3,420.1–6,802.6] and post-BIT 4,897.6 ± 3,067.4 [3,199.0–6,596.3], pre-CON 2,946.3 ± 1,675.2 [1,934.0–3,958.7] and post-CON 3,508.0 ± 2,000.6 [2,299.0–4,716.9].

Compliance to Training in Intervention Groups

Four subjects dropped out (2 women and 2 men) for not attending >90% of training sessions (Figure 1), and 1 dropped out for personal reasons. One man and 1 woman dropped out of the study because of musculoskeletal injuries (biceps femoris and rectus femoris tear, respectively) experienced during the SIT intervention. Fainting episodes, respiratory events, nausea, dizziness, and vomiting were not observed.

Training Response in Intervention Groups

During SIT, the subjects covered approximately 25-m each running bout. The training response was examined by considering the average value across the 4 sessions for each regimen. The variables analyzed were as follows: (a) adherence; (b) $\%HR_{peak}$; (c) energy expenditure; (d) CR-10 RPE; and (e) FS. Adherence % was not different between the groups (SIT = 93.3 ± 9.8 [87.9–98.3], BIT = 96.0 ± 8.3 [91.4–100.5], $t = -0.80$, $p = 0.42$, $d = 0.29$). Data show significant differences between the groups for $\%HR_{peak}$ (SIT = 83.2 ± 3.9 [81.1–85.3], BIT = 72.5 ± 9.2 [67.3–77.5], $t = 4.19$, $p < 0.001$, $d = 1.51$), energy expenditure (kcals) (SIT = 63.9 ± 13.4 [56.4–71.3], BIT = 47.5 ± 16.3 [38.5–56.9], $t = 2.99$, $p = 0.006$, $d = 1.09$), CR-10 RPE (SIT = 4.8 ± 1.8 [3.8–5.7], BIT = 2.6 ± 0.9 [2.0–3.0], $t = 4.27$, $p < 0.001$, $d = 1.55$), and FS (SIT = 2.7 ± 1.3 [2.0–3.4], BIT = 3.6 ± 1.0 [3.0–4.2], $t = -3.23$, $p = 0.002$, $d = 0.77$).

Changes in Cardiometabolic Parameters in All Groups

For body mass, BMI, muscle mass, fat mass, WC, HC, WHR, SBP, and DBP, no time × group interaction was detected ($p > 0.05$, $\eta^2 \leq 0.12$). Yet, a significant time × group interaction was noted for visceral fat mass ($p = 0.047$, $\eta^2 = 0.14$), and post hoc analysis showed that it was significantly reduced in response to BIT ($p = 0.05$, $d = 0.54$) compared with pretraining (Table 1).

Changes in Physical Parameters in all Groups

For $CMJ_{powerabs}$, $CMJ_{powerrel}$, 5-m sprint time, 10-m sprint time, $SRT_{Velocity}$, and $SRT\dot{V}O_{2max}$, results showed no time × group interaction ($p > 0.05$, $\eta^2 \leq 0.11$). However, there was a significant time × group interaction for CMJ_{height} ($p = 0.02$, $\eta^2 = 0.16$), and the post hoc analysis denoted higher CMJ_{height} in response to BIT ($p = 0.0014$, $d = 0.72$). Even though the improvement of CMJ height seems to be similar between BIT and CON, it should be noted that the coefficient of variation in CON (21.3%) was higher than in BIT (14.7%). Also, data exhibited a significant time × group interaction for $SRT_{distance}$ ($p = 0.02$, $\eta^2 = 0.17$), and pairwise comparisons showed an increased $SRT_{distance}$ in response to SIT ($p = 0.03$, $d = 0.62$) (Table 1).

Changes in Perceptual and Heart Rate Response in Intervention Groups

No time × group interaction for FS, CR-10 RPE, HR_{bas}, HR_{mean}, $\%HR_{peak}$, Kcals, HR_{end}, $HR_{60s\ end}$, $HR_{120s\ end}$, $RMSSD_{bas}$, $RMSSD_{end}$, R-R_{bas}, or R-R_{end} was detected during the training sessions ($p > 0.05$, $\eta^2 \leq 0.05$; Table 2). In addition, no time × group interaction was noted for change scores for $\Delta HR_{end\text{-}60s\ end}$, $\Delta HR_{end\text{-}120s\ end}$, $\Delta HR_{bas\text{-}end}$, $\Delta HR_{bas\text{-}60s\ end}$, $\Delta HR_{bas\text{-}120s\ end}$, $\Delta RMSSD_{bas\text{-}end}$, and ΔR-$R_{bas\text{-}end}$ during the training sessions ($p > 0.05$, $\eta^2 \leq 0.029$; Table 3).

Changes in Self-Efficacy and Intention Response in Intervention Groups

A significant frequency × group interaction was observed for self-efficacy after the training sessions ($F = 5.10$, $p = 0.032$, $\eta^2 = 0.15$). For SIT, the response was 93.3 ± 9.0 [88.3–98.3] for 1× a week, 84.0 ± 25.5 [69.8–98.1] for 2× a week, 73.3 ± 29.9 [56.7–98.1] for 3× a week, 58.0 ± 31.8 [40.3–75.6] for 4× a week, and 48.6 ± 29.9 [32.0–65.2] for 5× a week. For BIT, the response was 94.0 ± 8.2 [89.4–98.5] for 1× a week, 90.0 ± 15.1 [81.6–98.3] for 2× a week, 84.0 ± 19.9 [72.9–95.0] for 3× a week, 77.3 ± 23.4 [64.3–90.3] for 4× a week, and 71.3 ± 27.4 [56.1–86.5] for 5× a week. Significant intragroup differences were exhibited for SIT between 1× a week, 2× a week, and 3× a week vs. 4× a week, and 5× a week ($p < 0.05$, $d \leq 2.02$). Also, a significant intragroup difference was found for SIT between 4× a week vs. 5× a week ($p = 0.021$, $d = 0.30$). A significant intragroup difference was observed for BIT between 1× a week vs. 5× a week ($p = 0.034$, $d = 1.12$) and 2× a week vs. 4× a week and 5× a week ($p < 0.05$, $d \leq 0.84$). For the intergroup comparisons, the only difference was noted in 5× a week frequency, which being higher in BIT vs. SIT ($p = 0.040$, $d = 0.79$).

No intention × group interaction was detected for intention after the training sessions ($F = 0.43$, $p = 0.51$, $\eta^2 = 0.015$): intention 3× a week (SIT = 5.80 ± 1.26 [5.10–6.50], BIT = 5.27 ± 1.43 [4.47–6.06]), intention 5× a week (SIT = 4.07 ± 2.01 [2.95 to 5.18], BIT = 3.80 ± 1.61 [2.91 to 4.69]).

Discussion

This study is the first to compare cardiometabolic and physical adaptations to extremely low-volume HIFT (i.e., including only burpees, BIT) vs. SIT in real-world circumstances. During training, SIT elicited a greater physiological (i.e., $\%HR_{peak}$) and psychological (i.e., CR-10 RPE, and FS) response vs. BIT. Results showed that only 5 sessions of BIT consisting of 120 seconds of exercise per week was sufficient to improve vertical jump height. Furthermore, very low-volume SIT significantly improved total distance covered in SRT. Nevertheless, no changes were observed in body composition, blood pressure, 10-m sprint, $\dot{V}O_{2max}$, or autonomic balance variables. Finally, the self-efficacy was progressively worse for SIT than for BIT as sessions increased. Our initial hypothesis was met given that HIFT improved neuromuscular performance without changes in cardiorespiratory fitness compared with SIT.

Prior research suggests that low-volume interval training improves glycemic control, antioxidant status, and $\dot{V}O_{2max}$ in healthy and unhealthy adults (2,5,6,39,40,46). A novel strategy to improve $\dot{V}O_{2max}$ is reducing the metabolic stress of traditional SIT using shorter efforts (6). For example, Hazell et al. (18) noted similar changes in power output, time trial performance, and $\dot{V}O_{2max}$ in response to 6 sessions of short (i.e., 10 seconds) vs. long bouts (i.e., 30 seconds) of SIT. Vollaard and Metcalfe (46) reported that 18 sessions of two 10–20 seconds sprints across a 10-minute session induce improvements in $\dot{V}O_{2max}$ (+12%) and insulin sensitivity in sedentary young adults. Benítez-Flores et al. (5) showed that 6–12 "all-out" 5-second bouts applied over 6 sessions, requiring only approximately 13 minutes of training, improved $\dot{V}O_{2max}$ (+7%) similar to subjects performing SIT or SIT combined with strength training in young healthy adults. In addition, Schaun et al. (38) demonstrated that 16 weeks of SIT consisting of eight 20 seconds efforts at 130% $\dot{V}O_{2max}$ similarly increased time to exhaustion and $\dot{V}O_{2max}$ vs. HIFT. Our study used 4-second bouts, and data show that SIT did not alter $\dot{V}O_{2max}$ yet significantly enhanced distance during SRT, representing a moderate effect ($d = 0.62$, +5%). This improvement is substantial given the high baseline $\dot{V}O_{2max}$ (i.e., >52 $ml \cdot kg^{-1} \cdot min^{-1}$) of our subjects. The findings corroborate those in a recent meta-analysis in which HIFT was found to attenuate increases in cardiorespiratory fitness than traditional aerobic exercise (39). These outcomes may be associated with the lower $\%HR_{peak}$ for BIT than for SIT observed in this study (Table 2) and a prior study (3). In addition, prior work shows peripheral adaptations in skeletal muscle related to the improved mitochondrial function, such as

Table 1

Cardiometabolic and physical parameters.*†

Variable	Pretime SIT	Pretime BIT	Pretime CON	Posttime SIT	Posttime BIT	Posttime CON	Group effect F; p; η^2	Time effect F; p; η^2	Time vs. Group F; p; η^2
Body mass (kg)	71.7 ± 11.7 (65.2–78.1)	70.3 ± 8.7 (65.4–75.1)	71.0 ± 16.2 (61.2–80.8)	71.3 ± 10.8 (65.3–77.3)	69.1 ± 8.7 (64.3–74.0)	70.9 ± 15.5 (61.5–80.3)	0.13; 0.87; 0.006	4.75; 0.035§; 0.10	1.49; 0.23; 0.06
BMI (kg·m^{-2})	24.0 ± 1.9 (22.9–25.1)	24.5 ± 2.4 (23.1–25.8)	24.3 ± 3.0 (22.4–26.1)	23.9 ± 2.1 (23.0–24.9)	23.9 ± 2.1 (22.7–25.0)	24.2 ± 2.8 (22.5–25.9)	0.042; 0.95; 0.002	5.11; 0.029§; 0.11	2.58; 0.88; 0.11
Muscle mass (%)	36.1 ± 7.9 (31.7–40.4)	34.4 ± 6.2 (30.9–37.9)	33.8 ± 5.5 (30.4–37.1)	35.7 ± 8.2 (31.1–40.3)	35.3 ± 6.4 (31.7–38.9)	33.7 ± 5.7 (30.2–37.2)	0.77; 0.46; 0.035	0.38; 0.53; 0.01	2.23; 0.12; 0.10
Fat mass (%)	22.6 ± 7.2 (18.6–26.6)	27.2 ± 7.5 (23.1–31.4)	27.3 ± 5.9 (23.7–30.9)	22.5 ± 6.7 (18.8–26.3)	25.5 ± 7.5 (21.3–29.7)	27.4 ± 6.3 (23.6–31.2)	2.88; 0.067; 0.11	2.02; 0.16; 0.04	2.25; 0.11; 0.10
Visceral fat mass (%)	6.1 ± 1.6 (5.1–6.9)	6.6 ± 2.5 (5.1–8.0)	6.6 ± 3.0 (4.7–8.4)	6.0 ± 1.3 (5.2–6.7)	5.8 ± 2.0 (4.7–7.0)	6.6 ± 3.2 (4.7–8.6)	0.08; 0.92; 0.004	3.03; 0.08; 0.07	3.29; 0.047‖; 0.14
WC (cm)	76.7 ± 6.4 (73.1–80.3)	76.7 ± 5.7 (73.5–79.9)	76.4 ± 11.0 (69.7–83.1)	76.1 ± 5.6 (73.0–79.3)	76.6 ± 6.0 (73.2–79.9)	75.9 ± 10.9 (69.3–82.5)	0.058; 0.94; 0.003	3.63; 0.06; 0.083	0.42; 0.65; 0.02
HC (cm)	97.8 ± 5.1 (95.0–100.6)	99.5 ± 5.5 (96.4–102.5)	98.3 ± 8.0 (93.4–103.1)	98.0 ± 5.0 (95.2–100.8)	98.5 ± 4.7 (95.9–101.1)	97.9 ± 6.9 (93.7–102.1)	0.16; 0.85; 0.007	1.20; 0.27; 0.029	0.98; 0.38; 0.04
WHR	0.78 ± 0.05 (0.75–0.81)	0.77 ± 0.03 (0.74–0.79)	0.77 ± 0.07 (0.72–0.81)	0.77 ± 0.04 (0.75–0.80)	0.77 ± 0.04 (0.75–0.80)	0.77 ± 0.07 (0.72–0.81)	0.40; 0.66; 0.019	0.25; 0.61; 0.006	1.29; 0.28; 0.06
SBP (mm Hg)	124.9 ± 6.5 (121.3–128.5)	128.2 ± 10.1 (122.6–133.9)	135.8 ± 13.9 (127.4–144.2)	124.2 ± 7.3 (120.1–128.2)	126.8 ± 9.5 (121.5–132.1)	129.4 ± 11.3 (122.5–136.2)	1.43; 0.24; 0.063	5.96; 0.01§; 0.13	2.23; 0.12; 0.10
DPB (mm Hg)	74.7 ± 7.4 (70.6–78.8)	76.9 ± 6.1 (73.5–80.3)	83.9 ± 8.5 (78.7–89.0)	76.5 ± 8.3 (71.9–81.1)	75.4 ± 6.4 (71.8–79.0)	79.5 ± 9.4 (73.8–85.2)	2.44; 0.09; 0.10	1.72; 0.19; 0.04	2.91; 0.06; 0.12
CMJ_{height} (cm)	37.3 ± 7.1 (33.4–41.3)	33.1 ± 5.6 (30.0–36.3)	34.5 ± 5.7 (31.0–38.0)	36.5 ± 6.6 (32.8–40.2)	34.4 ± 6.2 (31.0–38.0)	36.0 ± 7.7 (31.3–40.7)	1.40; 0.25; 0.061	2.82; 0.10; 0.06	3.95; 0.02‖; 0.16
$CMJ_{powerabs}$ (W)	3,179.5 ± 537.3 (2,882.0–3,477.1)	3,225.3 ± 605.1 (2,890.1–3,560.4)	2,999.7 ± 438.5 (2,734.7–3,264.7)	3,334.5 ± 591.8 (3,006.7–3,662.2)	3,279.3 ± 567.5 (2,965.0–3,593.5)	3,298.4 ± 552.4 (2,964.5–3,632.2)	0.56; 0.57; 0.026	10.8; 0.002§; 0.21	1.86; 0.16; 0.08
$CMJ_{powerrel}$ (W·kg^{-1})	45.3 ± 9.7 (40.0–50.7)	46.2 ± 9.2 (41.1–51.4)	44.1 ± 11.0 (37.4–50.8)	47.8 ± 10.8 (41.8–53.8)	47.7 ± 8.4 (43.0–52.4)	48.7 ± 13.6 (40.4–57.0)	0.079; 0.92; 0.004	12.6; 0.001§; 0.24	1.28; 0.28; 0.06
5-m sprint time (s)	1.18 ± 0.08 (1.14–1.23)	1.23 ± 0.08 (1.19–1.28)	1.28 ± 0.12 (1.21–1.36)	1.16 ± 0.07 (1.12–1.20)	1.18 ± 0.08 (1.14–1.23)	1.27 ± 0.10 (1.21–1.33)	6.43; 0.004‡; 0.23	7.49; 0.009§; 0.15	1.24; 0.30; 0.05
10-m sprint time (s)	2.00 ± 0.15 (1.92–2.09)	2.08 ± 0.14 (2.00–2.16)	2.15 ± 0.18 (2.04–2.27)	1.97 ± 0.12 (1.91–2.04)	2.02 ± 0.15 (1.93–2.11)	2.14 ± 0.16 (2.03–2.24)	4.94; 0.012‡; 0.18	7.72; 0.008§; 0.16	0.80; 0.45; 0.03
$SRT_{velocity}$ (km·h^{-1})	12.8 ± 1.09 (12.2–13.4)	12.6 ± 1.00 (12.0–13.9)	12.5 ± 0.97 (11.9–13.0)	13.0 ± 1.07 (12.4–13.6)	12.6 ± 1.09 (12.0–13.2)	12.3 ± 0.96 (11.8–12.9)	1.45; 0.24; 0.063	0.24; 0.62; 0.006	2.86; 0.08; 0.11
SRT$\dot{V}O_{2max}$ (ml·kg^{-1}·min^{-1})	54.5 ± 7.2 (50.5–58.5)	53.4 ± 6.6 (49.7–57.1)	52.6 ± 6.4 (48.7–56.7)	55.7 ± 7.0 (51.8–59.7)	53.4 ± 7.0 (49.5–57.4)	52.0 ± 6.4 (48.0–55.8)	1.22; 0.30; 0.054	0.24; 0.62; 0.006	2.69; 0.08; 0.11
$SRT_{distance}$ (m)	1,628.0 ± 451.7 (1,377.8–1,878.1)	1,544 ± 417.9 (1,312.5–1,775.4)	1,504.6 ± 396.6 (1,264.9–1,744.3)	1,709.3 ± 461.0 (1,454.0–1,964.6)	1,553.3 ± 454.9 (1,301.3–1,805.2)	1,438.4 ± 368.8 (1,215.5–1,661.3)	1.37; 0.26; 0.16	0.15; 0.69; 0.004	4.18; 0.02‖; 0.17

*SIT = sprint interval training; BIT = burpees interval training; CON = control; BMI = body mass index; WC = waist circumference; HC = hip circumference; WHR = waist-to-hip ratio; SBP = systolic blood pressure; DBP = diastolic blood pressure; CMJ_{height} = countermovement jump height; $CMJ_{powerabs}$ = countermovement jump peak power absolute; $CMJ_{powerrel}$ = countermovement jump peak power relative; $SRT_{velocity}$ = shuttle run test velocity; SRT$\dot{V}O_{2max}$ = shuttle run test maximum oxygen consumption; $SRT_{distance}$ = shuttle run test distance.

†Data are expressed as mean ± *SD* and limits of the mean confidence interval (95%).

‡Significant group effect.

§Significant time effect.

‖Significant interactions between the factors; splits were performed: (a) visceral fat mass (%): analysis of group effects in the pretime and posttime, respectively: $F = 0.23$, $p = 0.23$, $\eta^2 = 0.01$ and $F = 0.50$, $p = 0.60$, $\eta^2 = 0.15$, respectively. Analysis of the effects of time in each group SIT, BIT, and CON, respectively: $t = 0.43$, $p = 0.67$, $d = 0.11$; **t = 2.120, p = 0.05, d = 0.54**; $t = -0.56$, $p = 0.58$, $d = 0.15$. (b) CMJ_{height} (cm): analysis of group effects in the pretime and posttime, respectively: $F = 1.77$, $p = 0.18$, $\eta^2 = 0.01$ and $F = 0.35$, $p = 0.60$, $\eta^2 = 0.15$. Analysis of the effects of time in each group SIT, BIT, and CON, respectively: $t = 1.15$, $p = 0.26$, $d = 0.19$; **t = −2.810, p = 0.0014, d = 0.72;** $t = -1.96$, $p = 0.07$, $d = 0.22$. (c) $SRT_{distance}$ (m): analysis of group effects in the pretime and posttime, respectively: $F = 0.31$, $p = 0.73$, $\eta^2 = 0.01$ and $F = 1.38$, $p = 0.26$, $\eta^2 = 0.06$. Analysis of the effects of time in each group SIT, BIT, and CON, respectively: **t = −2.400, p = 0.03, d = 0.62**; $t = -0.26$, $p = 0.79$, $d = 0.06$; $t = 1.77$, $p = 0.10$, $d = 0.49$.

Bolded terms in footnote indicate significant differences.

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Table 2

Perceptual and heart rate response during interval trainings.*†

Variable	SIT Session 1	SIT Session 2	SIT Session 3	SIT Session 5	BIT Session 1	BIT Session 2	BIT Session 3	BIT Session 5	Group effect *F*, *p*, η^2	Session effect *F*, *p*, η^2	Session vs. Group effect *F*, *p*, η^2
FS	3.00 ± 1.85 (1.97–4.02)	2.40 ± 1.91 (1.33–3.46)	2.80 ± 1.65 (1.88–3.71)	2.80 ± 1.82 (1.79–3.80)	3.53 ± 1.64 (2.62–4.44)	3.46 ± 1.06 (2.87–4.05)	3.80 ± 1.01 (3.23–4.36)	3.80 ± 1.14 (3.16–4.34)	4.32; 0.04‡; 0.13	0.40; 0.55; 0.02	0.33; 0.79; 0.01
CR-10 RPE	4.8 ± 2.1 (3.6–6.0)	5.2 ± 2.3 (3.8–6.5)	4.9 ± 2.0 (3.8–6.0)	4.1 ± 1.8 (3.0–5.1)	2.8 ± 1.1 (2.1–3.4)	2.7 ± 0.8 (2.3–3.1)	2.4 ± 1.0 (1.8–3.0)	2.3 ± 1.0 (1.7–2.9)§	18.2; <0.001‡; 0.39	2.88; 0.053; 0.09	0.75; 0.52; 0.02
HR_{bas}	66.2 ± 12.7 (59.1–73.2)	64.8 ± 8.7 (59.9–69.6)	64.3 ± 10.4 (58.5–70.1)	60.0 ± 8.2 (56.1–65.2)	61.4 ± 10.4 (55.6–67.2)	58.0 ± 10.3 (52.3–63.8)	58.9 ± 11.0 (52.8–65.0)	60.1 ± 10.9 (54.0–66.2)	1.92; 0.17; 0.06	1.30; 0.27; 0.045	1.12; 0.34; 0.03
HR_{mean}	161.4 ± 15.4 (152.8–169.9)	161.0 ± 12.3 (154.2–167.8)	158.2 ± 12.9 (151.0–165.4)	158.6 ± 12.0 (151.9–165.3)	137.3 ± 18.9 (126.8–147.8)	136.7 ± 20.1 (125.6–147.8)	136.3 ± 20.6 (124.9–147.7)	139.6 ± 20.4 (128.3–150.9)	14.3; 0.001‡; 0.33	0.73; 0.53; 0.02	1.26; 0.29; 0.04
$\%HR_{peak}$	84.0 ± 5.3 (81.0–87.0)	83.9 ± 4.4 (81.4–86.3)	82.4 ± 4.3 (80.0–84.8)	82.6 ± 4.2 (80.3–84.9)	72.4 ± 9.1 (67.3–77.5)	71.9 ± 10.1 (66.3–77.5)	71.8 ± 9.5 (66.5–77.1)	73.5 ± 9.5 (68.3–78.8)	17.5; <0.001‡; 0.38	0.75; 0.49; 0.02	1.29; 0.28; 0.04
Kcals	64.8 ± 14.5 (56.7–72.8)	64.0 ± 13.5 (56.5–71.6)	63.0 ± 13.7 (55.4–70.6)	63.7 ± 13.2 (56.3–71.0)	47.8 ± 16.9 (38.5–57.2)	47.0 ± 16.4 (37.9–56.2)	46.3 ± 17.0 (36.8–55.8)	48.9 ± 16.4 (39.7–58.0)	8.98; 0.006‡; 0.24	1.15; 0.33; 0.04	0.52; 0.66; 0.018
HR_{end}	172.1 ± 15.2 (163.6–180.4)	168.3 ± 11.3 (161.9–174.5)	166.1 ± 13.2 (158.7–173.3)	166.4 ± 12.6 (159.4–173.3)	152.9 ± 16.7 (143.6–162.1)	150.0 ± 18.7 (139.6–160.3)	149.0 ± 18.9 (138.5–159.5)	152.8 ± 18.9 (142.3–163.3)	9.44; 0.005‡; 0.25	3.63; 0.034§; 0.11	1.29; 0.28; 0.04
$HR_{60s\ end}$	125.2 ± 19.5 (114.3–136.0)	121 ± 16.1 (112.0–129.9)	117.9 ± 18.2 (107.7–127.9)	117.5 ± 18.1 (107.5–127.5)	100.8 ± 20.6 (89.3–112.2)	96.4 ± 20.9 (84.8–107.9)	94.2 ± 23.1 (81.4–107.0)	96.4 ± 26.7 (81.6–111.2)	11.1; 0.002‡; 0.28	3.65; 0.016§; 0.11	0.25; 0.85; 0.009
$HR_{120s\ end}$	105.6 ± 16.9 (96.1–115.0)	100.9 ± 12.5 (93.9–107.9)	98.0 ± 17.6 (88.3–107.8)	98.1 ± 16.5 (88.9–107.3)	87.2 ± 18.3 (77.0–97.3)	82.4 ± 18.0 (72.8–92.4)	80.6 ± 19.6 (69.9–91.7)	83.4 ± 21.8 (71.3–95.9)	7.79; 0.009‡; 0.21	5.77 0.001§; 0.170	0.50; 0.67; 0.018
$RMSSD_{bas}$	41.6 ± 20.1 (30.5–52.8)	40.8 ± 23.1 (28.0–53.6)	42.4 ± 16.4 (33.3–51.6)	53.3 ± 25.5 (39.2–67.4)	64.6 ± 32.6 (46.6–82.7)	68.3 ± 31.4 (50.9–85.7)	67.8 ± 26.5 (53.2–82.3)	72.6 ± 35.4§ (52.9–92.2)	7.61; 0.01‡; 0.21	2.49; 0.06; 0.08	0.39; 0.75; 0.01
$RMSSD_{end}$	10.4 ± 7.2 (6.4–14.4)	11.7 ± 9.1 (6.7–16.8)	12.0 ± 10.5 (6.2–17.9)	14.4 ± 14.5 (6.4–22.5)	25.2 ± 19.2 (14.5–35.9)	33.6 ± 25.5 (19.5–47.7)	35.8 ± 25.6 (21.7–50.0)	32.1 ± 25.3 (18.0–46.3)	9.72; 0.004‡; 0.25	3.26; 0.025§; 0.10	1.75; 0.16; 0.05
$R\text{-}R_{bas}$	932.7 ± 173.3 (836.7–1,028.7)	944.1 ± 147.8 (862.2–1,026.0)	946.1 ± 134.7 (871.5–1,020.6)	1,000.6 ± 125.7 (931.0–1,070.2)	994.4 ± 187.1 (890.8–1,098.0)	1,050.2 ± 202.6 (937.9–1,162.3)	1,037.2 ± 174.0 (940.8–1,133.6)	1,022.7 ± 185.7 (919.9–1,125.5)	1.76; 0.19; 0.05	1.25; 0.29; 0.04	1.05; 0.37; 0.03
$R\text{-}R_{end}$	426.8 ± 70.1 (388.0–465.6)	436.9 ± 56.9 (405.4–468.5)	449.9 ± 67.4 (412.6–487.3)	462.1 ± 65.6 (425.8–498.5)	555.7 ± 148.6 (473.4–638.0)	606.0 ± 175.9 (508.6–703.5)	626.5 ± 174.4 (529.9–723.2)	615.3 ± 207.0 (500.6–729.9)	11.56; 0.002‡; 0.29	5.70; 0.001§; 0.16	1.28; 0.28; 0.04

*SIT = sprint interval training; BIT = burpees interval training; FS = feeling scale; CR-10 RPE = rating of perceived exertion category ratio 10 scale; HR_{bas} = heart rate baseline; HR_{mean} = heart rate mean; $\%HR_{peak}$ = percentage of heart rate peak; HR_{end} = heart rate end; $HR_{end\text{-}60s\ end}$ = heart rate after 60 seconds of end; $HR_{end\ 120s\ end}$ = heart rate after 120 seconds of end; $RMSSD_{bas}$ = root mean square of successive differences between R-R intervals baseline; $RMSSD_{end}$ = root mean square of successive differences between R-R intervals end; $R\text{-}R_{bas}$ = R-R intervals baseline; $R\text{-}R_{end}$ = R-R intervals end.

†Data are expressed as mean ± *SD* and limits of the mean confidence interval (95%).

‡Significant group effect.

§Significant session effect.

Table 3

Changes scores of heart rate during interval trainings.*†

Variable	SIT Session 1	SIT Session 2	SIT Session 3	SIT Session 4	BIT Session 1	BIT Session 2	BIT Session 3	BIT Session 4	Group effect F; p; η^2	Session effect F; p; η^2	Session vs. Group effect F; p; η^2
$\Delta HR_{end\text{-}60s\ end}$	46.8 ± 15.4 (38.3–55.4)	47.2 ± 11.2 (41.0–53.4)	48.2 ± 11.9 (41.5–54.8)	48.8 ± 12.2 (42.0–55.5)	52.1 ± 12.1 (45.4–58.8)	53.6 ± 12.8 (46.4–60.7)	54.8 ± 15.3 (46.2–63.3)	56.4 ± 14.4 (48.4–64.3)	2.23; 0.14; 0.074	1.07; 0.36; 0.03	0.12; 0.94; 0.005
$\Delta HR_{end\text{-}120s\ end}$	66.4 ± 15.2 (58.0–74.9)	67.3 ± 7.5 (63.1–71.4)	68.0 ± 11.6 (61.5–74.4)	68.2 ± 11.8 (61.7–74.8)	65.7 ± 11.3 (59.4–72.0)	67.6 ± 10.9 (61.5–73.2)	68.2 ± 13.4 (60.7–75.6)	69.4 ± 11.5 (63.0–75.8)	1.02; 0.38; 0.035	0.003; 0.95; <0.001	0.11; 0.95; 0.004
$\Delta HR_{bas\text{-}end}$	105.8 ± 15.3 (97.3–114.3)	103.4 ± 7.9 (99.0–107.8)	101.7 ± 10.0 (96.1–107.2)	105.7 ± 12.5 (98.7–112.6)	91.4 ± 13.2 (84.1–98.7)	91.9 ± 13.9 (84.2–99.6)	90.1 ± 14.0 (82.3–97.8)	92.7 ± 13.4 (85.2–100.7)	9.62; 0.004‡; 0.25	1.21; 0.30; 0.042	0.26; 0.84; 0.010
$\Delta HR_{bas\text{-}60s\ end}$	59.0 ± 16.0 (50.1–67.8)	56.2 ± 10.1 (50.7–61.8)	53.5 ± 16.1 (44.5–62.5)	56.8 ± 15.7 (48.1–65.5)	39.3 ± 15.3 (30.0–47.8)	38.3 ± 13.7 (30.7–45.9)	35.3 ± 15.1 (27.0–43.7)	36.3 ± 19.0 (25.7–46.8)	15.3; 0.001‡; 0.35	1.48; 0.22; 0.050	0.15; 0.92; 0.005
$\Delta HR_{bas\text{-}120s\ end}$	39.4 ± 16.0 (30.5–48.2)	36.1 ± 10.2 (30.4–41.7)	33.7 ± 14.8 (25.5–41.9)	37.4 ± 14.8 (29.2–45.7)	25.7 ± 12.0 (19.0–32.4)	24.3 ± 10.4 (18.5–30.1)	21.9 ± 11.1 (15.7–28.1)	23.3 ± 13.2 (15.9–30.6)	9.51; 0.005‡; 0.25	2.11; 0.10; 0.07	0.21; 0.88; 0.008
$\Delta RMSSD_{bas\text{-}end}$	31.2 ± 21.3 (19.3–43.0)	29.0 ± 24.8 (15.2–42.8)	30.3 ± 19.3 (19.6–41.0)	38.9 ± 20.5 (27.5–50.2)	39.4 ± 30.4 (22.5–56.2)	34.6 ± 26.3 (20.0–49.2)	31.9 ± 23.8 (18.7–45.1)	40.5 ± 27.4 (25.2–55.7)	0.29; 0.59; 0.01	2.35; 0.07; 0.07	0.41; 0.74; 0.01
$\Delta R\text{-}R_{bas\text{-}end}$	505.8 ± 132.5 (432.4–579.2)	507.1 ± 113.9 (444.0–570.2)	496.1 ± 113.0 (433.5–558.7)	538.5 ± 110.7 (477.1–599.7)	438.7 ± 129.2 (367.1–510.2)	444.1 ± 114.2 (380.8–507.3)	410.6 ± 135.3 (335.6–485.5)	407.4 ± 104.6 (349.5–465.3)	7.12; 0.012‡; 0.20	0.36; 0.77; 0.013	0.84; 0.47; 0.029

*SIT = sprint interval training; BIT = burpees interval training; $\Delta HR_{end\text{-}60s\ end}$ = delta heart rate after 60 seconds of end; $\Delta HR_{end\text{-}120s\ end}$ = delta heart rate after 120 seconds of end; $\Delta HR_{bas\text{-}60s\ end}$ = delta heart rate after 60 seconds of end from baseline; $\Delta HR_{bas\text{-}120s\ end}$ = delta heart rate after 120 seconds of end from baseline; $\Delta RMSSD_{bas\text{-}end}$ = delta root mean square of successive differences between R-R intervals of end from baseline; $R\text{-}R_{bas\text{-}end}$ = R-R intervals of end from baseline.

†Data are expressed as mean ± *SD* and limits of the mean confidence interval (95%).

‡Significant group effect.

increased citrate synthase, cytochrome *c* oxidase subunit IV, and succinate dehydrogenase after 2 weeks of SIT (40). It is possible that some of these adaptations may explain gains in running performance in response to SIT, although further work is needed to confirm this result. Nevertheless, no significant increase in $\dot{V}O_{2max}$ was detected, possibly because of the very low dose of exercise per session (i.e., 40 seconds) and the total sessions performed (i.e., 5 sessions) compared with other studies showing significant increases in $\dot{V}O_{2max}$ with SIT (2,5,6,18,37,40). Despite these no significant findings, it is important to highlight that a gain of 1 $ml \cdot kg^{-1} \cdot min^{-1}$ in $\dot{V}O_{2max}$ was associated with a 9% relative risk reduction of all-cause mortality (23). Thus, our data could have substantial implications for the prevention of several diseases throughout adult life.

The importance of HR in detecting elevated risk of all-cause mortality has been identified (22). In fact, resting and exercise HR, HRR, and HRV are commonly used noninvasive field tools to evaluate adaptations in the regulation of the autonomic nervous system. After prolonged training, HRV and HRR fluctuate in accordance to training load and functional or nonfunctional overreaching (7). For example, moderate training loads generally promote an increase of vagal related HRV indices, whereas high training loads induce a decrease of vagal related HRV indices and slower HRR (7). Positive adaptations decrease the intrinsic rhythmicity of the heart through significant reductions in central sympathetic outflow as a consequence of enhancement in baroflex control and chemoreflex sensitivity (31). Moreover, there are enhancements in peripheral blood flow with increase in nitric oxide synthesis and reduction in cytokines (31). However, we did not detect any change in indicators of autonomic status after 5 sessions of BIT or SIT (Tables 2 and 3). Regarding HRV, there are divergent results concerning the efficacy of low-volume interval training (≥15 min $session^{-1}$). For example, 1 study using HIFT showed improvements in RMSSD and SDNN (42), whereas, another study using SIT did not (5). These equivocal data may be because of differences in training dose, as Songsorn et al. (42) implemented a longer dose of training vs. that of Benítez-Flores et al. (5) (6 vs. 2 weeks). Also, Songsorn et al. (42) recruited insufficiently active adults, whereas Benítez-Flores et al. (5) recruited moderately active adults. Our results also showed no effect of training on HRR. By contrast, Matsuo et al. (27) demonstrated enhanced HRR after 8 weeks of high-volume HIIT (3 × 3 minutes at 85% $\dot{V}O_{2max}$) in sedentary adults. The discrepant results may be explained by the different duration of recording, body position, training duration, type of exercise and training background.

Our results showed that BIT consisting of approximately 30 burpees per day significantly improved jump height. This is the first study exhibiting a moderate enhancement in muscle performance (d = 0.72, +4%; Table 1) in response to completing only burpees as part of HIFT. Nevertheless, there were no changes in absolute or relative peak power development during the jumps. Previously, Schaun et al. (37) reported an improvement in CMJ power output (+4%) and height (+6%) after 16 weeks of HIFT (8 minutes, 8 "all-out" × 20-second efforts) including 4 different exercises (burpees, mountain climbers, squat and thrusts with 3-kg dumbbells, and jumping jacks) in recreationally active adults. Evidence from a meta-analysis shows a significant effect of HIFT on 1 repetition maximum, longitudinal and vertical jump, and strength endurance (39). Therefore, HIFT may be a promising strategy for improving strength in active, non highly trained adults.

No exercise protocol is suitable for wide implementation unless it is well-tolerated by clientele. Our results showed no main effect or interaction for intention 3× a week or 5× a week for BIT or SIT. Previously, a greater intention to participate 5× a week was noted for BIT vs. SIT (28), which does not support our data. Moreover, we observed a significant trend toward lower self-efficacy across sessions for both groups. The self-efficacy score was progressively worse for SIT than for BIT as sessions increased, and significant differences were found in 5× a week frequency ($p = 0.040$, $d = 0.79$). Yet, the response was considerably positive for both protocols in self-efficacy and intention up to 3× a week frequency (i.e., ≥73/100 self-efficacy, ≥5/7 intention). These findings may be associated with minimal changes in CR-10 RPE (≤5, hard) and FS (≥3, good) during training, although a worse response was detected for SIT vs. BIT.

This study has a few limitations. First, data can only be applied to young, active, nonobese adults. Second, we implemented a very low dose of SIT and HIFT, and different findings may occur from regimens characterized by a higher training volume. Third, neither muscular strength nor $\dot{V}O_{2max}$ was measured directly in this study, and further work is needed to determine if these laboratory-based measures can be improved in response to low-volume BIT and SIT. Fourth, although HR is an ecological tool for assessing internal load, it is very sensitive to environmental changes.

Practical Applications

This study was designed to examine the implementation of extremely low-volume interval training in real-world circumstances. Our data in active adults show that 5 sessions of very low-volume running-based SIT enhances run distance, whereas BIT improves vertical jump height. Yet, no improvements were noted in body composition, blood pressure, $\dot{V}O_{2max}$, or autonomic modulation. These results exhibit fitness-related benefits with very low dose of exercise equivalent to 40 s d^{-1} with good adherence, tolerance, self-efficacy, and intention to engage 3× a week frequency. Thus, strength and conditioning professionals and enthusiasts should consider planning sessions with approximately 10 very short yet intense bouts to potentially mitigate sedentary behavior. However, strength and conditioning professionals have to apply running-based SIT with caution because it can cause musculoskeletal injury, and we suggest a preparatory training plan before starting "all-out" running SIT (e.g., submaximal sprint bouts) or completing other modalities (e.g., cycling or rowing). Another option is to design programs with HIFT because it is a modality with promising results in health indicators that has been established as one of the main trends in the fitness industry. Future studies should replicate these protocols in untrained, sedentary, or at-risk populations.

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We thank the participants for their dedication to the study. No potential conflict of interest was reported by the authors. The results of the present study do not constitute endorsement of the product by the authors or the NSCA. Data availability: All data obtained in this study are available within the article. Author contributions: P. Pérez-Ifrán: conceived and designed the investigation, analyzed and interpreted the data, drafted the paper, and approved the final version submitted for publication. C. A. Magallanes: conceived and designed the investigation, analyzed and interpreted the data, drafted the paper, and approved the final version submitted for publication. F. A. de S. Castro: analyzed and interpreted the data, drafted the paper, and approved the final version submitted for publication. T. A. Astorino: analyzed and interpreted the data, drafted the paper, and approved the final version submitted for publication. S. Benítez-Flores: conceived and designed the investigation, analyzed and interpreted the data, drafted the paper, and approved the final version submitted for publication. Institutional Ethics Committee Statement: The Ethics Committee from the Higher Institute of Physical Education, University of the Republic approved this study in accordance with the Declaration of Helsinki (November 4, 2020). Funding: This work was supported by the [CSIC, University of the Republic, Uruguay] under Grant [192, 2018].

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Contribución de publicaciones

Infelizmente está es la segunda vez que me presento al régimen de dedicación total y a pesar que al día de hoy (luego de 4 años) se me hace difícil asimilar/entender que aún no me haya podido acoplar al régimen, no he detenido mi producción científica priorizando siempre la calidad frente a la cantidad. Los tres artículos representan diferentes fases de mi formación como científico, pero todos giran en torno al mismo tema, analizar como pequeñas dosis de ejercicio de alta intensidad, pueden ser beneficiosas para la salud siendo más simples de practicar regularmente. Todos los artículos recibieron una revisión por pares a doble ciego, a continuación, paso a explicar brevemente cada uno de ellos:

1) El articulo 1 figuro como primer autor, fue publicado en el *European Journal of Applied Physiology* (creada en 1973), una revista alemana del segundo cuartil en el área de ciencias del deporte con un factor de impacto de 3.0. Este trabajo es un diseño controlado aleatorizado, en donde se observa que 6 sesiones de ~12 min de entrenamiento concurrente (EC) con esfuerzos máximos muy breves de 5 s, mejoran la fuerza muscular, el VO_2max y el estrés oxidativo en adultos jóvenes activos.
2) El articulo 2 figuro como cuarto autor, fue publicado en el *Scandinavian Journal of Medicine & Science In Sports* (creada en 1991), una revista dinamarquesa del primer cuartil en el área de ciencias del deporte con un factor de impacto de 4.1. Este trabajo es un meta-análisis, en donde se evidencia que el entrenamiento interválico de esprints (SIT) con esfuerzos máximos y submáximos breves (es decir, ≤10 s), incrementan significativamente el VO_2max y la potencia anaeróbica, independientemente de la modalidad de entrenamiento (es decir, corrida, remo, ciclismo, etc.) y el nivel de entrenamiento de los participantes (es decir, sedentarios, activos, atletas).
3) El articulo 3 figuro como ultimo autor, fue publicado en el *Journal of Strength and Conditioning Research* (creada en 1987), una revista estadounidense del primer cuartil en el área de ciencias del deporte con un factor de impacto de 3.2. Este trabajo es un diseño controlado aleatorizado, en donde se observa que 5 sesiones de ~8 min de entrenamiento interválico de burpees (BIT) con esfuerzos máximos muy breves de 4 s, mejoran la potencia muscular y la grasa visceral en adultos jóvenes activos.

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Universidade Católica de Brasilia , Brasil
Título de la disertación/tesis/defensa: Efectos de diferentes modos de entrenamiento intenso mediante esfuerzos muy cortos en las adaptaciones físicas y fisiológicas de adultos jóvenes
Tutor/es: Daniel Boullosa/Thiago Santos Rosa
Descripción del título obtenido: Doctor
Obtención del título: 2020
Sitio web de la disertación/tesis/defensa: https://bdtd.ucb.br:8443/jspui/handle/tede/2722
Financiación:
Agencia Nacional de Investigación e Innovación / Agencia Nacional de Investigación e Innovación , Uruguay
Palabras Clave: Entrenamiento interválico Entrenamiento concurrente Salud cardiometabólica Rendimiento físico
Areas de conocimiento:
Ciencias Médicas y de la Salud / Ciencias de la Salud / Ciencias del Deporte / Fisiología del Ejercicio

MAESTRÍA

Máster en Investigación en Actividad Física y Deporte (2012 - 2013)

Universidad de Málaga , España
Título de la disertación/tesis/defensa: Respuesta endocrina a la aplicación de vibraciones de cuerpo completo en humanos
Tutor/es: Margarita Carrillo/Jerónimo García Romero
Descripción del título obtenido: Magister
Obtención del título: 2014
Financiación:
Asociación Universitaria Iberoamericana de Posgrado , España
Palabras Clave: Plataformas vibratorias Vibraciones de cuerpo completo Sistema endocrino Hormonas
Areas de conocimiento:
Ciencias Médicas y de la Salud / Ciencias de la Salud / Ciencias del Deporte /

ESPECIALIZACIÓN/PERFECCIONAMIENTO

Posgrado en Farmacología, Nutrición y Suplementación en el Deporte (2011 - 2012)

Universidad de Barcelona , España
Título de la disertación/tesis/defensa: Programa sin defensa
Descripción del título obtenido: Posgraduado
Obtención del título: 2013
Areas de conocimiento:
Ciencias Médicas y de la Salud / Ciencias de la Salud / Nutrición, Dietética /

Internationale Trainerkurs (ITK) (2009 - 2010)

Universität Leipzig , Alemania
Título de la disertación/tesis/defensa: Programa sin defensa
Descripción del título obtenido: Especialista en Básquetbol
Obtención del título: 2010
Financiación:
Auswärtigen Amtes der Bundesrepublik Deutschland , Alemania
Areas de conocimiento:
Ciencias Médicas y de la Salud / Ciencias de la Salud / Ciencias del Deporte /

GRADO

Licenciatura en Educación Física (2005 - 2008)

Universidad de la República - Instituto Superior de Educación Física , Uruguay
Título de la disertación/tesis/defensa: Programa sin defensa
Descripción del título obtenido: Licenciado
Obtención del título: 2011
Areas de conocimiento:
Ciencias Médicas y de la Salud / Ciencias de la Salud / Ciencias del Deporte /

TÉCNICO

Tecnicatura en Básquetbol (2008 - 2009)

Institutos Terciarios no Universitarios - Escuela Nacional de Entrenadores Federación Uruguaya de Básquetbol , Uruguay
Título de la disertación/tesis/defensa: Programa sin defensa
Descripción del título obtenido: Técnico
Obtención del título: 2009
Areas de conocimiento:
Ciencias Médicas y de la Salud / Ciencias de la Salud / Ciencias del Deporte /

Tecnicatura en Fitness (2004 - 2004)

Instituto Universitario Asociación Cristiana de Jóvenes - Instituto Universitario "IUACJ" - Facultad de Educación Física , Uruguay
Título de la disertación/tesis/defensa: Programa sin defensa
Descripción del título obtenido: Técnico
Obtención del título: 2004
Areas de conocimiento:
Ciencias Médicas y de la Salud / Ciencias de la Salud / Ciencias del Deporte /

Formación complementaria

CONCLUIDA

POSDOCTORADOS

Rehabilitación cardiovascular (2022 - 2022)

Sector Extranjero/Internacional/Otros / Hospital Clinic, Universidad de Barcelona / Instituto Clínic Cardiovascular , España
Financiación:
Universidad de la República / Comisión Sectorial de Investigación Científica , Uruguay
Areas de conocimiento:
Ciencias Médicas y de la Salud / Biotecnología de la Salud / Biotecnología relacionada con la Salud /

CURSOS DE CORTA DURACIÓN

Fisiología cardiovascular y respiratoria humana en respuesta al ejercicio: bases teórico-prácticas para su comprensión y evaluación no-invasiva (06/2023 - 07/2023)

Sector Educación Superior/Público / Programa de Desarrollo de las Ciencias Básicas / Área Biología (PEDECIBA) , Uruguay
30 horas

8th EAPC Sports Cardiology Course (08/2022 - 08/2022)

Sector Extranjero/Internacional/Otros / Hospital Clinic, Universidad de Barcelona / Instituto Clínic Cardiovascular , España
8 horas

Bases Neurobiológicas del Sueño (10/2021 - 11/2021)

Sector Educación Superior/Público / Programa de Desarrollo de las Ciencias Básicas / Área Biología (PEDECIBA) , Uruguay
53 horas

Curso del programa estadístico STATA (04/2020 - 06/2020)

Sector Educación Superior/Público / Universidad de la República / Universidad de la República - Unidad Central de Educación Permanente , Uruguay
15 horas

Curso de Estadística aplicada a las Ciencias del Ejercicio (08/2019 - 11/2019)

Sector Extranjero/Internacional/Otros / Universidad de Valencia / Facultad De Fisioterapia , España
20 horas

Laboratorio de Comunicación Científica (05/2019 - 06/2019)

Sector Extranjero/Internacional/Otros / Agencia Española de Cooperación Internacional , España
20 horas

Laboratorio de Comunicación Científica (05/2019 - 05/2019)

Sector Extranjero/Internacional/Otros / Agencia Española de Cooperación Internacional , España
20 horas

Physiology: The science of life (04/2018 - 05/2018)

Sector Extranjero/Internacional/Otros / University of Liverpool , Inglaterra
20 horas

Scientific Quality, Position and Relevance in Sports Sciences (06/2015 - 07/2015)

Sector Extranjero/Internacional/Otros / Malmo University , Suecia
10 horas

Curso Superior de Entrenamiento en Fútbol (08/2011 - 11/2011)

Sector Extranjero/Internacional/Otros / Grupo Sobre Entrenamiento , Argentina
150 horas

Curso Internacional de Entrenamiento de la Fuerza (08/2010 - 10/2010)

Sector Extranjero/Internacional/Otros / Grupo Sobre Entrenamiento , Argentina
100 horas

Curso de Perfeccionamiento en Preparación Física y Deportiva (01/2007 - 01/2008)

Sector Extranjero/Internacional/Otros / Universidad de Ciencias Empresariales y Sociales , Argentina
300 horas

PARTICIPACIÓN EN EVENTOS

Evaluación pre-deportiva: de la persona sana al paciente con cardiopatía (2023)

Tipo: Seminario

Institución organizadora: Sociedad Uruguaya de Cardiología, Uruguay
Alcance geográfico: Local

Congreso Internacional de Nutrición y Deporte INANS (2023)

Tipo: Congreso
Institución organizadora: International Association of Nutrition and Sport (INANS), Costa Rica
Alcance geográfico: Internacional

How to Secure Peak Athletic Performance (2022)

Tipo: Seminario
Institución organizadora: Xsens, Holanda
Alcance geográfico: Internacional

1er Congreso Internacional sobre Optimización del Entrenamiento de Fuerza y Rendimiento Neuromuscular (2022)

Tipo: Congreso
Institución organizadora: Universidad de Granada, España
Alcance geográfico: Internacional

La Ciencia y la Aplicación del Entrenamiento Intervalado de Alta Intensidad (2022)

Tipo: Seminario
Institución organizadora: HIIT Science, Argentina
Alcance geográfico: Local

Jornadas Científicas: Actividad física del laboratorio a la práctica: ¿es posible personalizar el ejercicio físico? (2021)

Tipo: Seminario
Institución organizadora: NavarraBiomed, España
Alcance geográfico: Internacional

1st ELPA Performance International Congress (2021)

Tipo: Congreso
Institución organizadora: EuroLeague Players Association, Croacia
Alcance geográfico: Internacional

Fatiga y Rendimiento (2021)

Tipo: Simposio
Institución organizadora: Universidad Francisco de Vitoria, España
Alcance geográfico: Internacional

I Congreso Uruguayo de Ciencias Cognitivas & II Simposio de Educación, Cognición y Neurociencia (2021)

Tipo: Congreso
Institución organizadora: Sociedad Uruguaya de Ciencias Cognitivas y del Comportamiento, Uruguay
Alcance geográfico: Local

Development of a longitudinal study of ageing in Uruguay. Phase 1 Viability study (2020)

Tipo: Otro
Institución organizadora: Facultad de Enfermería, Udelar, Uruguay
Alcance geográfico: Internacional

25th Annual Congress of the European College of Sport Science (ECSS) (2020)

Tipo: Congreso
Institución organizadora: ECSS, España
Alcance geográfico: Internacional

Campus Party (2019)

Tipo: Encuentro
Institución organizadora: Campus Party, Uruguay
Alcance geográfico: Local

Pequeños Países, Grandes Oportunidades (2019)

Tipo: Otro
Institución organizadora: Grupo BID, Uruguay
Alcance geográfico: Local

MEGA Experiencia Endeavor 2019 (2019)

Tipo: Encuentro
Institución organizadora: Endeavor Uruguay, Uruguay
Alcance geográfico: Local

Miradas sobre el acceso a la literatura científica (2019)

Tipo: Seminario
Institución organizadora: CSIC, Udelar, Uruguay
Alcance geográfico: Local

Sucesos Científicos (2019)

Tipo: Simposio
Institución organizadora: UNESCO, Uruguay
Alcance geográfico: Local

38th World Congress of the International Union of Physiological Sciences (IUPS) (2017)

Tipo: Congreso
Institución organizadora: IUPS, Brasil
Alcance geográfico: Internacional

I Workshop de Ética na Pesquisa: Qual o papel da Universidade? (2017)

Tipo: Taller
Institución organizadora: Comitê de Ética em Pesquisa (CEP) da Universidade Católica de Brasília (UCB), Brasil
Alcance geográfico: Local

20th Annual Congress of the European College of Sport Science (ECSS) (2015)

Tipo: Congreso
Institución organizadora: ECSS, Suecia
Alcance geográfico: Internacional

Visita Universidad Europea de Madrid (2015)

Tipo: Otro
Institución organizadora: Escuela Universitaria Real Madrid, España
Alcance geográfico: Local

Visita Faculty of Health and Life Sciences (2015)

Tipo: Otro
Institución organizadora: Oxford Brookes University, Inglaterra
Alcance geográfico: Local

The Precision Medicine Revolution (2015)

Tipo: Simposio
Institución organizadora: ANII, Uruguay
Alcance geográfico: Local

Seminario de Cienciometría: tendencias y perspectivas (2014)

Tipo: Seminario
Institución organizadora: ANII, Uruguay
Alcance geográfico: Local

IV National Strenght and Conditioning Association (NSCA) Conference (2014)

Tipo: Congreso
Institución organizadora: NSCA, España
Alcance geográfico: Internacional

Entrenamiento de la Fuerza Aplicada al Rendimiento Físico y Deportivo (2013)

Tipo: Seminario
Institución organizadora: Máster en Rendimiento Físico y Deportivo. Universidad Pablo Olavide, España
Alcance geográfico: Local

Simposio de Flexibilidad (2009)

Tipo: Simposio
Institución organizadora: Intendencia de Maldonado, Uruguay
Alcance geográfico: Local

Campus de Alto Rendimiento Deportivo (2009)

Tipo: Otro
Institución organizadora: Club Atlético Boca Juniors, Uruguay
Alcance geográfico: Local

IV Encuentro Nacional de Estudiantes de Educación Física (2007)

Tipo: Encuentro
Institución organizadora: ISEF, Udelar, Uruguay
Alcance geográfico: Local

III Encuentro Nacional de Estudiantes de Educación Física (2006)

Tipo: Encuentro
Institución organizadora: ISEF, Udelar, Uruguay
Alcance geográfico: Local

EN MARCHA

CURSOS DE CORTA DE DURACIÓN

Curso Métodos Estadísticos Aplicados a la Investigación Clínica y Epidemiológica (06/2023)

Sector Educación Superior/Público / Universidad de la República / Facultad de Medicina / Departamento de Métodos Cuantitativos , Uruguay
168 horas

Idiomas

Alemán

Entiende regular / Habla regular / Lee regular / Escribe regular

Italiano

Entiende bien / Habla regular / Lee bien / Escribe regular

Catalán

Entiende bien / Habla regular / Lee bien / Escribe regular

Portugués

Entiende muy bien / Habla bien / Lee muy bien / Escribe bien

Inglés

Entiende bien / Habla bien / Lee muy bien / Escribe bien
Trinity Adults

Areas de actuación

CIENCIAS MÉDICAS Y DE LA SALUD

Ciencias de la Salud /Ciencias del Deporte /Fisiología del Ejercicio

Actuación profesional

SECTOR ORGANIZACIONES PRIVADAS SIN FINES DE LUCRO/SOCIEDADES CIENTÍFICO-TECNOLÓGICAS - SOCIEDADES CIENTÍFICO-TECNOLÓGICAS - URUGUAY

Investiga uy - asociación de investigadoras e investigadores del Uruguay

VÍNCULOS CON LA INSTITUCIÓN

Colaborador (01/2024 - a la fecha)

Integrante comisión I+D 2 horas semanales
Investiga uy se propone ser la organización que representa a investigadores e investigadoras del Uruguay, de todas las áreas del conocimiento. Objetivos: 1) Promover la democratización y la creación de conocimiento en sus más diversas formas; así como su uso y aplicación por parte de la sociedad. 2) Contribuir al fortalecimiento y expansión de las políticas de fomento a la investigación en todas las ramas del conocimiento, promoviendo la participación de las/os investigadoras/es en los ámbitos de gobernanza de la investigación. 3) Promover la equidad del acceso a la formación y trabajo en investigación, apuntando a eliminar todo tipo de discriminación y marginación. 4) Colaborar con instituciones públicas, privadas y la sociedad civil en la implementación y el desarrollo de políticas que promuevan la investigación. 5) Velar por condiciones adecuadas de trabajo en investigación, y promover la apertura de mejores oportunidades laborales para jóvenes investigadoras e investigadores.

SECTOR EXTRANJERO/INTERNACIONAL/OTROS - ESPAÑA

FiveStars

VÍNCULOS CON LA INSTITUCIÓN

Profesor visitante (07/2023 - a la fecha)

Profesor 2 horas semanales
FiveStars Fitness es una escuela que brinda una formación deportiva con un método de enseñanza fiable, dinámico y, lo más importante, con la capacidad de ser adaptado a tu horario y tus necesidades. En este sentido FiveStars cambia la concepción del aprendizaje y pone todas las mejores herramientas a tu alcance para que completes tu curso de capacitación deportiva mediante una metodología revolucionaria a través de realidad virtual interactiva en 360º guiada por un profesor y un asistente práctico con el cual podrás comentar en directo cualquier duda que tengas. FiveStars es una empresa registrada en el Servicio Público de Empleo Estatal de España con código 2300076082 para impartir de forma presencial dos certificados de profesionalidad relacionados con la familia de actividades físicas y deportivas, cuyas referencias son: AFDA0110 y AFDA0210

ACTIVIDADES

DOCENCIA

Máster Entrenamiento Personal (07/2023 - a la fecha)

Maestría
Invitado
Asignaturas:
Planificación del entrenamiento cardiorrespiratorio, 6 horas, Teórico

SECTOR EXTRANJERO/INTERNACIONAL/OTROS - CHILE

Red Interuniversitaria de Envejecimiento Saludable, Latinoamérica y Caribe

VÍNCULOS CON LA INSTITUCIÓN

Colaborador (05/2023 - a la fecha)

2 horas semanales
La Red Interuniversitaria de Envejecimiento Saludable para Latinoamérica y el Caribe (RIES-LAC) se propone promover el envejecimiento saludable, mediante la articulación entre las universidades

de Latinoamérica y el Caribe, para el desarrollo de conocimiento interdisciplinario, la formación de capital humano avanzado, y la generación de propuestas de políticas públicas que mejoren la calidad de vida de las personas mayores

SECTOR EXTRANJERO/INTERNACIONAL/OTROS - ESPAÑA

Strenght and Conditioning Society

VÍNCULOS CON LA INSTITUCIÓN

Colaborador (01/2023 - a la fecha)

Colaborador 2 horas semanales
The Strenght and Conditioning Society (SCS) is a non-profit, international association devoted to fostering scientific research in the field of strength and conditioning. Through its sport sciences and clinical multi-disciplinary team of professionals, SCS aims to examine strength training and conditioning from a multifaceted perspective, including all physiological, biomechanical, psychological and epidemiological aspects. Thus, it strives to improve knowledge in the area of strength and conditioning and its broad application to sports performance, injury prevention, rehabilitation, and health improvement. It contributes to the dissemination of this knowledge to the scientific community and encourages initiatives aimed at increasing public awareness of findings in terms of strength and conditioning research and practice

SECTOR EXTRANJERO/INTERNACIONAL/OTROS - ESPAÑA

Hospital Clinic, Universidad de Barcelona / Instituto Clínic Cardiovascular

VÍNCULOS CON LA INSTITUCIÓN

Colaborador (08/2022 - a la fecha)

Investigador 2 horas semanales

ACTIVIDADES

PROYECTOS DE INVESTIGACIÓN Y DESARROLLO

Desenmascarando la fibrilación auricular inducida por el ejercicio: un estudio multimodal, desde la adaptación cardíaca al ejercicio hasta el patrón de entrenamiento y la carga psicológica (08/2022 - a la fecha)

Los beneficios de moderados volúmenes de ejercicio físico en salud cardiovascular y global son innumerables. Sin embargo, altos volúmenes de ejercicio físico se han confirmado como factor de riesgo para fibrilación auricular. Este proyecto intenta dilucidar el rol de los diferentes parámetros relacionados con el ejercicio físico (modalidad, volumen, intensidad, tiempo de recuperación, sobreentrenamiento, estrés, etc.) en el desarrollo de la fibrilación auricular
2 horas semanales
Hospital Clinic, Universidad de Barcelona , Instituto Clínic Cardiovascular
Investigación
Integrante del Equipo
En Marcha
Alumnos encargados en el proyecto:
Especialización:2
Doctorado:2
Financiación:
Ministerio de Ciencia e Innovación, España, Apoyo financiero
Equipo: de la Garza, M (Responsable) , Rodas Font, G (Responsable) , Benítez-Flores, S , Domenech, B , Caparrós, A

PASANTÍAS

Pasantía Servicios Médicos FC Barcelona (08/2022 - 12/2022)

Servicios Médicos, Cardiología deportiva
10 horas semanales

SECTOR EXTRANJERO/INTERNACIONAL/OTROS - ESTADOS UNIDOS

International Association of Nutrition and Sport

VÍNCULOS CON LA INSTITUCIÓN

Colaborador (10/2021 - a la fecha)

Colaborador 2 horas semanales
Con presencia en 23 países International Association of Nutrition and Sport (INANS) se propone investigar, actualizar, difundir, innovar y generar nuevos conocimientos que puedan ser empleados como fundamentos estandarizados, científicamente sustentados, a favor de la ciencia, por la nutrición y el deporte

SECTOR EDUCACIÓN SUPERIOR/PÚBLICO - PROGRAMA DE DESARROLLO DE LAS CIENCIAS BÁSICAS - URUGUAY

Área Biología (PEDECIBA)

VÍNCULOS CON LA INSTITUCIÓN

Funcionario/Empleado (07/2021 - a la fecha) Trabajo relevante

Responsable 6 horas semanales

ACTIVIDADES

LÍNEAS DE INVESTIGACIÓN

Adaptaciones fisiológicas del entrenamiento interválico para la salud (07/2021 - a la fecha)

Esta línea propone indagar las adaptaciones fisiológicas que ocurren a nivel cardiometabólico y neuromuscular luego de intervenciones aplicando entrenamiento interválico en poblaciones saludables y no saludables
Aplicada
8 horas semanales , Coordinador o Responsable
Equipo: Benítez-Flores, S , Ferrando-Castagnetto, F , Ferraro-Farro, D , Trujillo-Baameiro, D , Astorino, TA

SECTOR EDUCACIÓN SUPERIOR/PRIVADO - UNIVERSIDAD DE MONTEVIDEO - URUGUAY

Centro de Ciencias Biomédicas / Curso avanzado de Medicina del Deporte

VÍNCULOS CON LA INSTITUCIÓN

Otro (04/2019 - a la fecha)

Profesor invitado 2 horas semanales

ACTIVIDADES

DOCENCIA

Curso Avanzado en Medicina del Deporte (07/2020 - a la fecha)

Especialización
Invitado
Asignaturas:
Evaluación y monitorización del entrenamiento de la fuerza, 3 horas, Teórico-Práctico
Evaluación y monitorización del entrenamiento de la resistencia, 3 horas, Teórico-Práctico

SECTOR EDUCACIÓN SUPERIOR/PÚBLICO - UNIVERSIDAD DE LA REPÚBLICA - URUGUAY

Instituto Superior de Educación Física

VÍNCULOS CON LA INSTITUCIÓN

Funcionario/Empleado (12/2018 - a la fecha) Trabajo relevante

Asistente 20 horas semanales
Escalafón: Docente
Grado: Grado 2
Cargo: Interino

ACTIVIDADES

LÍNEAS DE INVESTIGACIÓN

Efectos del entrenamiento interválico en la salud y el rendimiento humano (03/2020 - a la fecha)

Esta línea está centrada en indagar sobre el impacto que tiene el entrenamiento interválico de manera aguda/crónica a nivel fisiológico y psicológico en poblaciones jóvenes universitarias, como una estrategia para la mejora de la salud y la aptitud física
Aplicada
4 horas semanales
Departamento de Educación Física y Salud, Núcleo biológico , Coordinador o Responsable
Equipo: Benítez-Flores, S , Ferraro-Farro, D , Trujillo-Baameiro, D , Astorino, TA

PROYECTOS DE INVESTIGACIÓN Y DESARROLLO

Factores determinantes de la agilidad pre-planeada y reactiva en el Básquetbol moderno (03/2019 - a la fecha)

Este proyecto pretende indagar sobre los posibles factores determinantes de la agilidad pre-planeada y reactiva en distintas categorías/niveles del Básquetbol moderno
4 horas semanales
Departamento de Educación Física y Salud , Núcleo biológico
Investigación
Coordinador o Responsable
En Marcha
Alumnos encargados en el proyecto:
Maestría/Magister:1
Equipo: Benítez-Flores, S (Responsable) , Calleja-González, J (Responsable) , Pérez-Ifrán, P , Boullosa, DA , Brini, S

¿Existe el efecto de interferencia cuando se aplica entrenamiento concurrente incorporando Sprint Interval Training (SIT)? (11/2023 - a la fecha)

Este proyecto se propone la elaboración de un meta-análisis analizando si el SIT como régimen de entrenamiento interválico, induce un efecto de interferencia en las adaptaciones neuromusculares como previamente fue descrito con otros modelos de entrenamiento de resistencia
2 horas semanales
School of Physical Education, Physiotherapy and Dance, Federal University of Rio Grande do Sul , Exercise Research Laboratory
Investigación
Coordinador o Responsable
En Marcha
Alumnos encargados en el proyecto:
Maestría/Magister:2
Equipo: Benítez-Flores, S (Responsable) , Cadore, EL (Responsable) , Ferraro-Farro, D , Bandeira, M

Effect of acute supplementation on maximal strength and anaerobic power (01/2024 - a la fecha)

The project proposes to investigate the acute effects of Beetroot (dietary nitrate) supplementation on maximal strength and anaerobic power in young healthy adults
3 horas semanales
University of Cambridge , Mini-PhD Global Programme 2024: Food Science & Sports Nutrition
Investigación
Coordinador o Responsable
En Marcha
Alumnos encargados en el proyecto:
Pregrado:10
Maestría/Magister:2

Equipo: Benítez-Flores, S (Responsable) , González, D (Responsable) , Redha, A (Responsable) , Magallanes, CA (Responsable) , Ferraro-Farro, D , Trujillo-Baameiro, D

Impactos clínicos, funcionales y autonómicos de la rehabilitación cardíaca precoz en pacientes sometidos a intervencionismo percutáneo primario tras un infarto con elevación del segmento ST (11/2022 - a la fecha)

La enfermedad cardiovascular es la primera causa de mortalidad a nivel mundial e implica un problema mayor de salud pública. Dentro de ellas destaca la enfermedad arterial coronaria (EAC). El síndrome coronario agudo con elevación del segmento ST o infarto agudo de miocardio (IAM) es un evento coronario grave que muchas veces representa el debut de la enfermedad, cuyos impactos sobre la morbimortalidad y calidad de vida de los sujetos afectados son enormes. La revascularización miocárdica precoz a través de angioplastia percutánea (ATC) ha demostrado reducir la severidad y las complicaciones del IAM, disminuyendo la estancia hospitalaria y el tiempo de reincorporación del sujeto a sus actividades cotidianas. Por otra parte, dada la eficacia y seguridad de la rehabilitación cardiovascular (RC), las guías de práctica clínica, tanto europeas como norteamericanas, recomiendan la actividad física regular y supervisada como herramienta fundamental en la prevención primaria y secundaria de la enfermedad cardiovascular. El efecto de la RC en los portadores de enfermedad coronaria ha sido extensamente estudiado, informando una reducción del 20-26% en la mortalidad total y cardíaca, respectivamente. Tras un IAM, el ejercicio físico integrando la RC es una intervención con efectos positivos sobre la mortalidad, la capacidad funcional y la calidad de vida. Por lo tanto, este proyecto pretende comparar los efectos de diferentes intervenciones de ejercicio físico analizando los mecanismos dosis-respuesta, además observar si el momento que comienza la RC (precoz versus tardía) afecta las adaptaciones alcanzadas
10 horas semanales
Hospital de Clínicas , Centro Cardiovascular Universitario (CCVU)
Investigación
Coordinador o Responsable
En Marcha
Alumnos encargados en el proyecto:
Pregrado:2
Especialización:2
Maestría/Magister:2
Financiación:
Hospital de Clínicas, Uruguay, Apoyo financiero
Equipo: Benítez-Flores, S (Responsable) , Ferrando-Castagnetto, F (Responsable) , Murguía, S , Garretano, A , Ferraro-Farro, D , Trujillo-Baameiro, D , Ricca-Mallada, R , Gurascier, C

Comparación de los efectos de tres modalidades de entrenamiento intenso en parámetros de salud cardiometabólica y aptitud física (12/2018 - 12/2022)

La incidencia de enfermedades no transmisibles (ENT) ha crecido exponencialmente en las últimas décadas. La inactividad física se ha asociado positivamente con la fisiopatología de muchas de estas enfermedades, teniendo una gran repercusión en el gasto sanitario y la mortalidad en todo el mundo. Frente a esta problemática compleja, la Actividad Física (AF) aparece como una intervención económica y de amplia aplicación para la prevención y tratamiento de estas enfermedades, presentando una fuerte evidencia científica. Un gran número de investigaciones señalan los beneficios cardiometabólicos que aporta la AF de alta intensidad. El "High Intensity Interval Training" (HIIT) ha mostrado ser un método de entrenamiento particularmente eficaz por ser de fácil aplicación, adecuada tolerancia y bajo tiempo de implicancia semanal. Sin embargo, gran parte de los trabajos presentes en la literatura realizan comparaciones de propuestas muy diferentes en cuanto a los parámetros de carga, y en muchas ocasiones el volumen de tiempo excede las recomendaciones de AF semanal de ejercicio intenso. Por otro lado, existe necesidad de estudiar propuestas de AF más emparentadas con la vida cotidiana, fuera de situaciones controladas de laboratorio. Por lo tanto, el objetivo del presente proyecto es investigar los efectos de tres programas de entrenamiento intenso de simple aplicación y equiparados en sus cargas de trabajo (volumen e intensidad) en marcadores de rendimiento físico y salud cardiometabólica
20 horas semanales
Departamento de Educación Física y Salud , Núcleo biológico
Investigación
Coordinador o Responsable
Concluido
Alumnos encargados en el proyecto:
Pregrado:2
Financiación:

Comisión Sectorial de Investigación Científica, Uruguay, Apoyo financiero
Equipo: Benítez-Flores, S (Responsable) , Magallanes, CA (Responsable) , Pérez-Ifrán, P , Acuña, A , Parodi, A

Short Sprint Interval Training in Performance and Health (03/2020 - 02/2022)

The aim of this systematic review with meta-analysis was to identify controlled (CTs) and randomized controlled trials (RCTs) that used very short efforts ~ 10 s over a minimum of 2 weeks, which is the minimum time required to induce stable adaptations, and to verify the effects of these training regimes on measures of aerobic and anaerobic fitness and performance. To avoid the confounding effect of training history (i.e., to be sedentary), age (maturational factors or aging), and clinical conditions (e.g., obese and cardiovascular disease), we decided to only include healthy physically active adults and athletes
4 horas semanales
Cologne German Sport University , Department of Molecular and Cellular Sports Medicine
Investigación
Integrante del Equipo
Concluido
Alumnos encargados en el proyecto:
Maestría/Magister:2
Equipo: Boullosa, DA (Responsable) , Schumann, M (Responsable) , Dragutinovic, B , Benítez-Flores, S , Feuerbacher, JF

DOCENCIA

Licenciatura de Educación Física (03/2020 - a la fecha)

Grado
Responsable
Asignaturas:
Seminario de Tesis Salud, 4 horas, Teórico-Práctico

Licenciatura en Educación Física (05/2021 - a la fecha)

Grado
Responsable
Asignaturas:
Fundamentos Anátomo-Fisiológicos, 15 horas, Teórico-Práctico

Programa de Maestría en Educación Física (05/2020 - a la fecha)

Maestría
Responsable
Asignaturas:
Seminario de Tesis, 2 horas, Teórico

Licenciatura en Educación Física (04/2021 - 05/2023)

Grado
Responsable
Asignaturas:
Iniciación a la Investigación, 6 horas, Teórico-Práctico

Licenciatura en Educación Física (08/2020 - 12/2020)

Grado
Responsable
Asignaturas:
Educación Física Adaptada para Poblaciones Especiales, 5 horas, Teórico

Licenciatura de Educación Física (01/2020 - 12/2020)

Grado
Asistente
Asignaturas:
Fisiología del Ejercicio, 15 horas, Teórico

Formación Permanente (05/2019 - 12/2019)

Perfeccionamiento
Responsable

Asignaturas:
HIIT ¿De qué estamos hablando?, 45 horas, Teórico-Práctico

GESTIÓN ACADÉMICA

Comisión asesora Especializaciones (07/2020 - a la fecha)

Comisión Académica de Posgrados Gestión de la Enseñanza 2 horas semanales

Comisión académica XVIII Encuentro Nacional XIII Internacional de Investigadores en Educación Física (03/2020 - 10/2020)

Unidad de Apoyo a la Investigación Gestión de la Investigación 2 horas semanales

Co-creador del programa de la asignatura Educación Física Adaptada para Poblaciones Especiales (02/2020 - 06/2020)

Departamento de Educación Física y Salud Gestión de la Enseñanza 2 horas semanales

SECTOR EMPRESAS/PRIVADO - EMPRESA PRIVADA - URUGUAY

GeneXus / ThalesLAB

VÍNCULOS CON LA INSTITUCIÓN

Otro (09/2018 - a la fecha)

2 horas semanales

ACTIVIDADES

OTRA ACTIVIDAD TÉCNICO-CIENTÍFICA RELEVANTE

Desarrollo de la APP Simple Training. Simple Training es una APP que se dedica a establecer contactos entre personas que requieren programas de entrenamiento físico y entrenadores personales de diversas áreas. También brinda herramientas de evaluación y control de las sesiones para los entrenadores buscando una optimización del trabajo práctico (10/2018 - a la fecha)

4 horas semanales

SECTOR EDUCACIÓN SUPERIOR/PÚBLICO - UNIVERSIDAD DE LA REPÚBLICA - URUGUAY

Centro Universitario de Investigación, Innovación y Diagnóstico Arterial

VÍNCULOS CON LA INSTITUCIÓN

Colaborador (08/2018 - 12/2020)

Investigador 6 horas semanales
Centro Universitario de Investigación y Diagnóstico Arterial (CUIIDARTE) se dedica al estudio no invasivo de la estructura y función hemodinámica y biomecánica, normal y alterada, del sistema cardiovascular. En sus laboratorios se cuenta con equipamiento de última generación para llevar adelante desde estudios en simuladores cardiovasculares, experimentación animal y/o estudios vasculares no-invasivos para el diagnóstico precoz de enfermedad cardiovascular
Escalafón: No Docente

ACTIVIDADES

LÍNEAS DE INVESTIGACIÓN

Relaciones entre niveles de actividad física y función hemodinámica en la población uruguaya (08/2018 - 12/2020)

Este estudio intenta describir niveles de actividad física en diversas poblaciones de Uruguay mediante acelerometría, indagando sus relaciones con el funcionamiento y estructura cardiovascular y arterial

Aplicada
6 horas semanales
Facultad de Medicina, Departamento de Fisiología , Integrante del equipo
Equipo: Bia Santana, D , Zócalo, Y , Benítez-Flores, S , Zinoveev, A , Castro, JM , García-Espinosa, V , Marin, M

SECTOR GOBIERNO/PÚBLICO - MINISTERIO DE SALUD PÚBLICA - URUGUAY

Programa de Prevencion de Enfermedades No Transmisibles

VÍNCULOS CON LA INSTITUCIÓN

Colaborador (04/2015 - 05/2016)

Colaborador 2 horas semanales
Grupo interdisciplinario que aborda con reuniones semanales problemáticas vinculadas a las enfermedades no transmisibles en la sociedad uruguaya

SECTOR EMPRESAS/PRIVADO - EMPRESA PRIVADA - URUGUAY

CASMU / Casmu Vital

VÍNCULOS CON LA INSTITUCIÓN

Funcionario/Empleado (10/2014 - 08/2015) Trabajo relevante

Tecnólogo/Investigador 12 horas semanales
El Casmu Vital es un programa creado desde una perspectiva interdisciplinar y con un abordaje integral, para el tratamiento y rehabilitación de múltiples patologías cardiometabólicas (obesidad, hipertensión, diabetes, etc.), procurando también mejorar la calidad de vida de los individuos

SECTOR EXTRANJERO/INTERNACIONAL/OTROS - ARGENTINA

Grupo Sobre Entrenamiento

VÍNCULOS CON LA INSTITUCIÓN

Otro (01/2013 - 08/2015)

Organización Asociada 12 horas semanales
El Grupo Sobre Entrenamiento (G-SE) es el Líder Mundial en Información y Capacitación a Distancia en Ciencias del Ejercicio y Salud. Con más de 20 años online, alberga aprox. 800 capacitaciones a distancia, 5000 artículos y blogs, y 500 debates científicos de una comunidad de más de 300.000 profesionales de las ciencias del ejercicio. Mediante una organización asociada al G-SE, se realizaron numerosas actividades formativas (Webinarios, Seminarios, Talleres, etc.), incluyendo la participación de grandes referentes mundiales del entrenamiento en deportes colectivos: Dr. Julio Calleja-González, Dra. Anne Delextrat, Dra. Lorena Torres Ronda, Dr. Oliver Gonzalo Skok, Dr. Xavi Shelling, Dr. Luis Suarez Arrones, entre otros.

ACTIVIDADES

DOCENCIA

Curso Internacional de Entrenamiento en Deportes Colectivos (Avalado por el ACSM) (08/2013 - 12/2014)

Especialización
Responsable
Asignaturas:
Entrenamiento de la Velocidad y la Agilidad en Deportes Colectivos, 3 horas, Teórico

GESTIÓN ACADÉMICA

Coordinador Curso Internacional de Entrenamiento en Deportes Colectivos (Avalado por el ACSM) (08/2013 - 12/2014)

Grupo Sobre Entrenamiento Gestión de la Enseñanza 5 horas semanales

SECTOR EMPRESAS/PRIVADO - EMPRESA PRIVADA - URUGUAY

Club Malvín

VÍNCULOS CON LA INSTITUCIÓN

Funcionario/Empleado (03/2009 - 08/2015)

Profesor de Educación Física 15 horas semanales
Profesor de diversas modalidades de fitness/deportes: entrenamiento deportivo para Básquetbol (planteles femeninos), entrenamiento de fuerza, inestable o vibratorio para tercera edad, entrenamiento de resistencia o concurrente para poblaciones obesas, entrenamiento de fuerza para poblaciones activas e inactivas

SECTOR EMPRESAS/PRIVADO - EMPRESA PRIVADA - URUGUAY

Instituto Universitario Asociación Cristiana del Jóvenes

VÍNCULOS CON LA INSTITUCIÓN

Funcionario/Empleado (05/2014 - 05/2015)

Tutor tesis de grado 4 horas semanales

SECTOR EXTRANJERO/INTERNACIONAL/OTROS - ESPAÑA

Universidad de Málaga / Facultad de Ciencias de la Educación

VÍNCULOS CON LA INSTITUCIÓN

Becario (10/2012 - 08/2013)

Investigador 12 horas semanales
La pasantía se completó dentro del laboratorio de biodinámica y composición corporal. Dicho laboratorio cuenta con equipos y profesionales cualificados en el campo de la fisiología del ejercicio. Están preparados para realizar evaluaciones de composición corporal y biodinámica en el propio laboratorio; además, posee medios para la instalación de laboratorios portátiles en diferentes contextos. Esta variabilidad hace que se puedan completar análisis de diversa índole, y posibilita una gran adaptabilidad para heterogéneos contextos/poblaciones

ACTIVIDADES

PROYECTOS DE INVESTIGACIÓN Y DESARROLLO

Gasto energético, obesidad y salud infantil (GEOS) (10/2012 - 08/2013)

El objetivo del siguiente proyecto es evaluar el gasto energético, los hábitos de alimentación y la composición corporal de escolares andaluces ¿Es la intervención escolar de los profesores Educación Física una real arma en la guerra contra la obesidad?
4 horas semanales
Facultad de Ciencias de la Educación , Laboratorio de Biodinámica y Composición Corporal
Investigación
Integrante del Equipo
Concluido
Alumnos encargados en el proyecto:
Maestría/Magister prof:4
Doctorado:2
Financiación:
Ministerio de Ciencia e Innovación, España, Apoyo financiero
Equipo: Carnero, EA (Responsable) , Alvero- Cruz, JR (Responsable) , Carrillo De Albornoz, M , Correas-Gómez, L , Benítez-Porres, J , Benítez-Flores, S

The relationship between Body Composition and Anaerobic Development in Elite and Subelite Young

Basketballs Players (10/2012 - 08/2013)

The aim of this research is to establish the relationships between molecular and cellular body composition with maximum strength, vertical jumps, linear sprint and agility in young basketball players. Also, the second aim is to compare the physical and morphological profile throughout different levels of competition (i.e., Elite vs. Subelite)
2 horas semanales
Facultad de Ciencias de la Educación , Laboratorio de Biodinámica y Composición Corporal
Investigación
Integrante del Equipo
En Marcha
Alumnos encargados en el proyecto:
Doctorado:2
Equipo: Carnero, EA (Responsable) , Benítez-Flores, S (Responsable) , Alvero- Cruz, JR , Carrillo De Albornoz, M , Correas-Gómez, L , Calleja-González, J , López-Raya, J , Rojo-Rodríguez, J , Gil-Guerrero, T

DOCENCIA

Maestro. Especialidad en Educación Física (03/2013 - 07/2013)

Grado
Invitado

SECTOR EMPRESAS/PRIVADO - EMPRESA PRIVADA - URUGUAY

Club Trouville / Federación Uruguaya de Basketball

VÍNCULOS CON LA INSTITUCIÓN

Funcionario/Empleado (02/2012 - 09/2012)

Preparador Físico categorías formativas Serie 1 16 horas semanales

SECTOR EMPRESAS/PRIVADO - EMPRESA PRIVADA - URUGUAY

Institución Deportiva Guruyú Waston / Federación Uruguaya de Basketball

VÍNCULOS CON LA INSTITUCIÓN

Funcionario/Empleado (06/2011 - 12/2011)

Preparador Físico primera división LUB 25 horas semanales

SECTOR EMPRESAS/PRIVADO - EMPRESA PRIVADA - URUGUAY

Club Sportivo Capitol / Federación Uruguaya de Basketball

VÍNCULOS CON LA INSTITUCIÓN

Funcionario/Empleado (02/2010 - 12/2010)

Preparador Físico categorías formativas Serie 2 8 horas semanales

SECTOR EMPRESAS/PRIVADO - EMPRESA PRIVADA - URUGUAY

Racing Club de Montevideo / Asociación Uruguaya de Fútbol

VÍNCULOS CON LA INSTITUCIÓN

Funcionario/Empleado (04/2010 - 09/2010)

Preparador Físico categorías formativas División 1 8 horas semanales

SECTOR EMPRESAS/PRIVADO - EMPRESA PRIVADA - URUGUAY

Club Ateneo de Piriapolis / Federación Uruguaya de Basketball

VÍNCULOS CON LA INSTITUCIÓN

Funcionario/Empleado (08/2008 - 11/2008)

Preparador Físico primera división DTA 8 horas semanales

SECTOR EMPRESAS/PRIVADO - EMPRESA PRIVADA - URUGUAY

Club Ateneo de Piriapolis / Federación Uruguaya de Basketball

VÍNCULOS CON LA INSTITUCIÓN

Funcionario/Empleado (02/2008 - 11/2008)

Preparador Físico categorías formativas Serie 3 10 horas semanales

SECTOR EMPRESAS/PRIVADO - EMPRESA PRIVADA - URUGUAY

Perfil Gym

VÍNCULOS CON LA INSTITUCIÓN

Funcionario/Empleado (01/2006 - 08/2008)

Profesor de Educación Física 8 horas semanales
Profesor de diversas modalidades de fitness/deportes: Spinning para poblaciones activas e inactivas, entrenamiento de fuerza para poblaciones activas e inactivas, entrenamiento de resistencia para corredores

CARGA HORARIA

Carga horaria de docencia: 6 horas
Carga horaria de investigación: 10 horas
Carga horaria de formación RRHH: Sin horas
Carga horaria de extensión: Sin horas
Carga horaria de gestión: Sin horas

Producción científica/tecnológica

La práctica de actividad física (AF) es la intervención sobre el estilo de vida que produce la regularización más profunda sobre cientos de genes implicados en el mantenimiento de los tejidos y la homeostasis. Además de ser una terapia que induce efectos multisistémicos; es de bajo coste económico, puede ser adaptable a cualquier población y si es bien dosificada no provoca efectos secundarios. Así, estudios de cohorte prospectivos evidenciaron de manera contundente, que mayores niveles de AF se asocian a un menor riesgo de enfermedad por cualquier causa y un aumento en la expectativa de vida. Sin embargo, según un estudio reciente, un 25% de los adultos y un 80% de los adolescentes no cumple con las recomendaciones de AF (150-300 min/semana de intensidad moderada o 75-150 min/semana de intensidad vigorosa); siendo descrita como principal barrera la falta de tiempo. De hecho, en el año 2013, la inactividad física fue responsable de un costo en los sistemas de salud y pérdidas de productividad equivalentes a US$ 67500 billones en todo el mundo. El entrenamiento interválico (popularizado en el ámbito deportivo desde la década de los 50), se ha consolidado como una gran terapia física, ya que con un menor compromiso de tiempo semanal, ha manifestado notables beneficios para la salud en poblaciones saludables y no saludables según numerosos meta-análisis. El entrenamiento interválico consiste básicamente en la ejecución de intervalos de alta intensidad (de 5 s a 4 min), con recuperaciones activas/pasivas entre los mismos, permitiendo a lo largo de una sesión un mayor tiempo acumulado en zonas de alta demanda cardiorrespiratoria. Actualmente, dentro del entrenamiento interválico, sesiones muy cortas (iguales o menores a 15 min) han demostrado su eficiencia en mejorar parámetros cardiometabólicos tales como; consumo máximo de oxigeno (VO2max), grasa corporal, presión arterial, etc. Adicionalmente, la realización de intervalos muy breves (iguales o menores a 15 s) son mejor tolerados y más placenteros que intervalos largos o protocolos continuos, sin atenuar las adaptaciones fisiológicas. Más recientemente ha surgido el interés por otro tipo de enfoque interválico denominado high-intensity functional training (HIFT), en dónde se hacen ejercicios multiarticulares de fuerza con el propio peso corporal tales como; burpees, push-ups, mountain climbers, jumping jacks, etc. Dichos modelos pueden inducir efectos cardiorrespiratorios y neuromusculares superiores a los protocolos convencionales de entrenamiento interválico realizados en bicicleta, cinta, remo, etc. Por lo tanto, mi investigación apunta a indagar el impacto agudo/crónico en variables físicas, fisiológicas y clínicas ligadas a la salud cardiometabólica, que inducen diferentes modelos de entrenamiento interválico de bajo volumen en ambientes hospitalarios y también en ambientes de mundo real; con el objetivo de simplificar su implementación y mejorar la adherencia longitudinal, tanto en poblaciones activas, inactivas o patológicas.

Producción bibliográfica

ARTÍCULOS PUBLICADOS

ARBITRADOS

Vertical jump and relative strength are strongly associated with change of direction in professional male basketball players (Completo, 2024)

Benítez-Flores, S , Cadore, EL , Stojanovic, E , Delextrat, A , Calleja-González, J
International Journal of Strength and Conditioning, 2024
Medio de divulgación: Internet
E-ISSN: 26342235
DOI: https://doi.org/10.47206/ijsc.v4i1.279
https://journal.iusca.org/index.php/journal/

Extremely low-volume burpee interval training equivalent to 8 minutes per session improves vertical jump compared to sprint interval training in real-world circumstances (Completo, 2023) Trabajo relevante

Pérez-Ifrán, P , Magallanes, CA , De Souza, FA , Astorino, TA , Benítez-Flores, S
The Journal of Strength and Conditioning Research, v.: 38 1 , 2023
Medio de divulgación: Internet
E-ISSN: 15334287
DOI: 10.1519/JSC.0000000000004603
https://journals.lww.com/nsca-jscr
Scopus WEB OF SCIENCE™

Quality of lean body mass and jump capacity in high performance young basketball players (Completo, 2023) Trabajo relevante

Correas-Gómez, L , Benítez-Flores, S , Carnero, EA , Calleja-González, J
Journal of Sports Sciences, 41 18, 2023
Medio de divulgación: Internet
ISSN: 02640414
E-ISSN: 1466447X
DOI: 10.1080/02640414.2023.2291294
https://www.tandfonline.com/toc/rjsp20/current
Scopus WEB OF SCIENCE™

Change of direction performance and their physical determinants among young basketball male players (Completo, 2022)

Pérez-Ifrán, P , Rial, M , Brini, S , Calleja-González, J , Del Rosso, S , Boullosa, DA , Benítez-Flores, S
Journal of Human Kinetics, v.: 85 2022
Medio de divulgación: Internet
ISSN: 16405544
E-ISSN: 18997562
DOI: 10.2478/hukin-2022-0107
https://johk.pl/
Scopus WEB OF SCIENCE™

Sprint interval training attenuates neuromuscular function and vagal reactivity compared to high intensity functional training in real-world circumstances (Completo, 2022) Trabajo relevante

Benítez-Flores, S , De Souza, FA , Cadore, EL , Astorino, TA
The Journal of Strength and Conditioning Research, v.: 37 5 , 2022

Medio de divulgación: Internet
E-ISSN: 15334287
DOI: 10.1519/JSC.0000000000004358
https://journals.lww.com/nsca-jscr
Scopus WEB OF SCIENCE™

Burpee interval training is associated with a more favorable affective valence and psychological response than traditional high intensity exercise (Completo, 2022)

Mayr-Ojeda, E , De Souza, FA , Reich, M , Astorino, TA , Benítez-Flores, S
Perceptual and Motor Skills, v.: 129 3 , 2022
Medio de divulgación: Internet
ISSN: 00315125
E-ISSN: 1558688X
DOI: 10.1177/00315125221083180
https://journals.sagepub.com/home/pms
Scopus WEB OF SCIENCE™

Effects of short sprint interval training on aerobic and anaerobic indices: A systematic review and meta-analysis (Completo, 2022) Trabajo relevante

Boullosa, DA , Dragutinovic, B , Feuerbacher, J , Benítez-Flores, S , Coyle, E , Schumann, M
Scandinavian Journal of Medicine and Science in Sports, v.: 32 5 , 2022
Medio de divulgación: Internet
E-ISSN: 16000838
DOI: 10.1111/sms.14133
https://onlinelibrary.wiley.com/journal/16000838
Scopus WEB OF SCIENCE™

Physiological and psychological responses to three distinct exercise training regimens performed in an outdoor setting: acute and delayed response (Completo, 2021)

Benítez-Flores, S , Magallanes, CA , Alberton, CL , Astorino, TA
Journal of Functional Morphology and Kinesiology, v.: 6 2021
Medio de divulgación: Internet
E-ISSN: 24115142
DOI: 10.3390/jfmk6020044
https://www.mdpi.com/journal/jfmk
Scopus WEB OF SCIENCE™

Relationships between field tests performances in elite goalball players (Completo, 2019)

Goulart-Siqueira, G , Benítez-Flores, S , Ferreira, A , Moura-Zagatto, A , Boullosa, DA , Foster, C
Sports, v.: 7 1 , 2019
Medio de divulgación: Internet
E-ISSN: 20754663
DOI: 10.3390/sports7010006
https://www.mdpi.com/journal/sports
Scopus WEB OF SCIENCE™

Combined effects of very short all out efforts during sprint and resistance training on physical and physiological adaptations after 2 weeks of training (Completo, 2019) Trabajo relevante

Benítez-Flores, S , Medeiros, AR , Voltarelli, FA , Iglesias-Soler, E , Doma, K , Simões, HG , Santos-Rosa, T , Boullosa, DA
European Journal of Applied Physiology, v.: 119 2019
Medio de divulgación: Internet
ISSN: 14396319
E-ISSN: 14396327
DOI: 10.1007/s00421-019-04125-6
https://link.springer.com/journal/421
Scopus WEB OF SCIENCE™

Improvements in attention and cardiac autonomic modulation after a 2-weeks sprint interval training program: A fidelity approach (Completo, 2018)

de Sousa, A , Medeiros, AR , Benítez-Flores, S , Del Rosso, S , Boullosa, DA , Stults-Kolehmainen, M
Frontiers in Physiology, v.: 9 2018

Medio de divulgación: Internet
E-ISSN: 1664042X
DOI: 10.3389/fphys.2018.00241
https://www.frontiersin.org/journals/physiology
Scopus WEB OF SCIENCE™

Shorter sprints elicit greater cardiorrespiratory and mechanical responses with less fatigue during time-matched sprint interval training (SIT) sessions (Completo, 2018)

Benítez-Flores, S , de Sousa, A , Da Cunha, EC , Santos-Rosa, T , Del Rosso, S , Foster, C , Boullosa, DA
Kinesiology, v.: 50 2 , 2018
Medio de divulgación: Internet
ISSN: 13311441
E-ISSN: 1848638X
DOI: 10.26582/k.50.2.13
https://hrcak.srce.hr/ojs/index.php/kinesiology/article/view/5783
Scopus WEB OF SCIENCE™

Respuesta endocrina a la aplicación de vibraciones de cuerpo completo en humanos (Completo, 2015)

Benítez-Flores, S , Carillo de Albornoz, M , García-Romero, J
Revista Andaluza de Medicina del Deporte, v.: 8 3 , 2015
Medio de divulgación: Internet
ISSN: 18887546
E-ISSN: 21725063
DOI: 10.1016/j.ramd.2015.04.002
https://www.elsevier.es/es-revista-revista-andaluza-medicina-del-deporte-284
Scopus latindex

LIBROS

A Comprehensive Guide to Exercise Medicine (Participación , 2024)

Benítez-Flores, S
Editorial: IntechOpen
Tipo de puplicación: Divulgación
Referado
Escrito por invitación
Medio de divulgación: Internet
ISSN/ISBN:

Capítulos:
Interval training
Organizadores: Hidetaka Hamasaki
Página inicial 0, Página final 0

PUBLICACIÓN DE TRABAJOS PRESENTADOS EN EVENTOS

Entrenamiento funcional de alta intensidad en la rehabilitación cardiovascular de la enfermedad coronaria con componente microvascular (2023)

Gurascier, C , Garretano, A , Niell, N , Benítez-Flores, S
Publicado
Completo
Evento: Nacional
Descripción: CardioSUC 2023
Ciudad: Punta del Este
Año del evento: 2023
Anales/Proceedings:Caso Clínico
Volumen:36
Publicación arbitrada
Medio de divulgación: Internet
https://cardiosuc2023.suc.org.uy/

Minimal doses of burpee interval training equivalent to 40-s of exercise per day improves vertical jump after 5 sessions (2022)

Benítez-Flores, S , Pérez-Ifrán, P , Acuña, A , Magallanes, CA , De Souza, FA , Astorino, TA
Publicado
Completo
Evento: Internacional
Descripción: 1er Congreso Internacional sobre Optimización del Entrenamiento de Fuerza y Rendimiento Neuromuscular
Ciudad: Granada
Año del evento: 2022
Publicación arbitrada
Medio de divulgación: Papel
Financiación/Cooperación:
Comisión Sectorial de Investigación Científica / Apoyo financiero, Uruguay

Physical activity evaluated by accelerometry: Equivalence between hip and wrist recordings & association with IPAQ, body composition and muscular power (2019)

Benítez-Flores, S , Bia Santana, D , Zócalo, Y
Publicado
Completo
Evento: Internacional
Descripción: II Pan-American Congress of Physiological Sciences
Ciudad: La Habana
Año del evento: 2019
Publicación arbitrada
Medio de divulgación: Papel
Financiación/Cooperación:
Comisión Sectorial de Investigación Científica / Apoyo financiero, Uruguay
https://www.iups.org/

Acute physiological responses of very short versus standard sprint interval training (SIT) protocols (2017)

Benítez-Flores, S , de Sousa, A , Da Cunha, EC , Santos-Rosa, T , Del Rosso, S , Foster, C , Boullosa, DA
Publicado
Completo
Evento: Internacional
Descripción: 64th American College of Sports Medicine (ACSM) Anual Meeting
Ciudad: Denver
Año del evento: 2017
Anales/Proceedings:Thematic Poster; High Intensity Training
Publicación arbitrada
Medio de divulgación: Papel
https://www.acsm.org/

Fidelidade ao treinamento intervalado de sprints na atenção seletiva em estudantes universitários (2017)

de Sousa, A , Medeiros, AR , Benítez-Flores, S , Del Rosso, S , Stults-Kolehmainen, M , Boullosa, DA
Publicado
Completo
Evento: Nacional
Descripción: VI Congresso Associação Brasileira de Psicologia do Esporte
Año del evento: 2017
Publicación arbitrada
Medio de divulgación: Papel
https://www.abrapesp.org.br/

Two-weeks of sprint interval training improves selective attention in university students (2017)

Medeiros, AR , de Sousa, A , Benítez-Flores, S , Del Rosso, S , Stults-Kolehmainen, M , Boullosa, DA
Publicado
Completo
Evento: Internacional
Descripción: 22nd Annual Congress of the European College of Sport Science (ECSS)
Ciudad: Ruhr
Año del evento: 2017
Publicación arbitrada
Medio de divulgación: Internet

https://sport-science.org/

Perfil físico-fisiológico del básquetbol actual (2014)

Benítez-Flores, S , Calleja-González, J
Publicado
Completo
Evento: Internacional
Descripción: III Congreso de Punta
Ciudad: Punta del Este
Año del evento: 2014
Medio de divulgación: Papel
https://congresodepunta.com/

Relationship between Hydration and Jump Performance: Differences Between Elite and Regional Young Basketball Players (2013)

Carnero, EA , Benítez-Flores, S , Carillo de Albornoz, M , López-Raya, J , Rojo-Rodríguez, J , Gil-Guerrero, T
Publicado
Completo
Evento: Internacional
Descripción: Primer Congreso Internacional de Hidratación. Coca-Cola Company
Ciudad: Madrid
Año del evento: 2013
Publicación arbitrada
Medio de divulgación: Otros
http://www.riuma.uma.es/xmlui/handle/10630/6809

Producción técnica

PRODUCTOS

Plan de Fuerza, Entrenamiento Inestable y Flexibilidad (FEIF) (2011)

Producto, Otra
Balseiro, L , Benítez-Flores, S
Programa para la mejora de la funcionalidad y el riesgo de lesiones asociadas a las caídas en el adulto mayor
País: Uruguay
Disponibilidad: Restricta
Institución financiadora: Club Malvín
Medio de divulgación: Otros
http://www.clubmalvin.net/
Este programa fue creado para la prevención de lesiones musculoesqueléticas asociadas a las caídas y la mejora de la funcionalidad en el adulto mayor, utilizando herramientas modernas fundamentadas en la evidencia científica (entrenamiento isoinercial, entrenamiento vibratorio, entrenamiento en suspensión, sensobalance, etc.). Por el mismo han pasado mas de 100 usuarios con resultados altamente satisfactorios en relación a la potenciación de variables como la estabilidad, el balance, la fuerza, la funcionalidad y la flexibilidad

Plan de Nutrición y Ejercicio Físico (NEF) (2010)

Producto, Otra
Balseiro, L , Benítez-Flores, S
Programa creado específicamente para el tratamiento del Sobrepeso y la Obesidad. En el mismo, se aplican intervenciones nutricionales y de ejercicio físico, utilizando las principales tendencias basadas en evidencia
País: Uruguay
Disponibilidad: Restricta
Institución financiadora: Club Malvín
Medio de divulgación: Otros
http://www.clubmalvin.net/
El Plan NEF (Nutrición y Ejercicio Físico) nace con la necesidad de crear un programa que aborde desde una perspectiva multidisciplinar el Sobrepeso y la Obesidad. En el mismo participan médicos deportólogos, licenciados en Nutrición y licenciados en Educación física. Se han conseguido cambios en la composición corporal, variables de riesgo cardiometabólico, rendimiento físico y estilo de vida

con mas de 200 usuarios

TRABAJOS TÉCNICOS

Asesor científico para Aerobic Instituto de Cultura Física (2018)

Asesoramiento
Benítez-Flores, S
Asesoramiento al Staff de profesores sobre modalidades y tendencias actuales del fitness, herramientas confiables para evaluar la condición física, maneras de evaluar los efectos crónicos de múltiples modalidades de entrenamiento, formas de prescribir/dosificar el entrenamiento en diversas poblaciones usando el conocimiento científico
País: Uruguay
Idioma: Español
Disponibilidad: Restricta

https://www.aerobic.com.uy/
Este asesoramiento técnico se propuso mejorar la calidad y rigurosidad del servicio brindado por los profesores del Aerobic-Instituto de Cultura Física, siendo reflejada esta acción en una mejor atención al socio desde una perspectiva vanguardista

OTRAS PRODUCCIONES

PROGRAMAS EN RADIO O TV

Sobre Ciencia (2023)

Benítez-Flores, S
Entrevista
País: Uruguay
Idioma: Español
Web: https://sobreciencia.uy/
Emisora: TV CIUDAD
Fecha de la presentación: 27/09/2023
Tema: Efectos del ejercicio físico intenso en la salud cardiometabólica
Duración: 15 minutos
Ciudad: Montevideo

Sobre Ciencia (2020)

Benítez-Flores, S
Entrevista
País: Uruguay
Idioma: Español
Web: https://sobreciencia.uy/
Emisora: Radio Uruguay
Fecha de la presentación: 15/04/2020
Tema: Pequeñas dosis de ejercicio físico diario pueden mejorar la salud cardiometabólica
Duración: 10 minutos
Ciudad: Montevideo

Justicia infinita (2019)

Benítez-Flores, S
Entrevista
País: Uruguay
Idioma: Español
Web: https://www.m24.com.uy/justicia-infinita/
Emisora: Oceano FM
Fecha de la presentación: 15/11/2019
Tema: Importancia del ejercicio físico en la salud y los problemas que existen en la actualidad en el área
Duración: 20 minutos
Ciudad: Montevideo

Evaluaciones

EVALUACIÓN DE PUBLICACIONES

REVISIONES

Scientific Reports (2023)
Tipo de publicación: Revista
Cantidad: Menos de 5

Sports Medicine (2023)
Tipo de publicación: Revista
Cantidad: Menos de 5

Perceptual and Motor Skills (2023)
Tipo de publicación: Revista
Cantidad: De 5 a 20

Frontiers in Physiology (2022)
Tipo de publicación: Revista
Cantidad: De 5 a 20

Retos (2022)
Tipo de publicación: Revista
Cantidad: De 5 a 20

Motriz (2022)
Tipo de publicación: Revista
Cantidad: Menos de 5

PeerJ (2021)
Tipo de publicación: Revista
Cantidad: Menos de 5

International Journal of Sports Physiology and Performance (2021)
Tipo de publicación: Revista
Cantidad: De 5 a 20

Research Quarterly for Exercise and Sport (2021)
Tipo de publicación: Revista
Cantidad: Menos de 5

PLOS ONE (2019)
Tipo de publicación: Revista
Cantidad: De 5 a 20

Revista Andaluza de Medicina del Deporte (2019)
Tipo de publicación: Revista
Cantidad: De 5 a 20

Revista Brasileira de Ciência e Movimento (2017)
Tipo de publicación: Revista
Cantidad: Menos de 5

Revista Universitaria de la Educación Física y el Deporte (2016)
Tipo de publicación: Revista
Cantidad: Menos de 5

EVALUACIÓN DE CONVOCATORIAS CONCURSABLES

Llamado interino de 1 (un) cargo, Grado 2, 20 horas semanales para desempeñar tareas en el Departamento Ed. Física y Salud, Núcleo Fundamentos Biológicos (2022 / 2022)
Comité evaluador

Uruguay
Cantidad: Menos de 5
ISEF, Montevideo

Llamado interino de 1 (un) cargo, Grado 1, 20 horas semanales para desempeñar tareas en el Departamento Ed. Física y Salud, Núcleo Fundamentos Biológicos (2022 / 2022)

Comité evaluador
Uruguay
Cantidad: Menos de 5
ISEF, Montevideo

Becas de Posgrados Nacionales 2020 (2021)

Evaluación independiente
Uruguay
Cantidad: Menos de 5
ANII, Uruguay

Proyectos de Iniciación a la Investigación 2019 (2020)

Evaluación independiente
Uruguay
Cantidad: Menos de 5
CSIC, Udelar

JURADO DE TESIS

Doctorado PROINBIO (2023)

Jurado de mesa de evaluación de tesis
Sector Educación Superior/Público / Universidad de la República / Facultad de Medicina , Uruguay
Nivel de formación: Doctorado
Nombre: Programa de entrenamiento específico de Goleros para atajar penales. Alumno: Manuel Elbio Aquino

Licenciatura en Educación Física (2022)

Jurado de mesa de evaluación de tesis
Sector Educación Superior/Público / Universidad de la República / Instituto Superior de Educación Física , Uruguay
Nivel de formación: Grado
Nombre: La imaginería motora en el campo de la educación física: Una revisión y actualización de su utilización en deportistas. Alumno: Diego Bouza, Rosina Elgue, Pablo Iguini, Santiago Sabini

Licenciatura en Educación Física (2022)

Jurado de mesa de evaluación de tesis
Sector Educación Superior/Público / Universidad de la República / Instituto Superior de Educación Física , Uruguay
Nivel de formación: Grado
Nombre: Ejercicio físico y mejora del rendimiento cognitivo: una revisión de las hipótesis explicativas. Alumno: Pablo Martín Izquierdo Rodríguez, Juan Ignacio Pérez Laguna, Julián Andrés Pérez Conde, Rodrigo Damián Pérez Valdez

Licenciatura en Educación Física (2022)

Jurado de mesa de evaluación de tesis
Sector Educación Superior/Público / Universidad de la República / Instituto Superior de Educación Física , Uruguay
Nivel de formación: Grado
Nombre: Relación de los perfiles fuerza velocidad en futbolistas profesionales uruguayos. Alumno: Yonhatan Bentancor, Micaela Bermúdez, Germán Correa, Facundo Currais, Rodrigo Pino

Licenciatura en Educación Física (2021)

Jurado de mesa de evaluación de tesis
Sector Educación Superior/Público / Universidad de la República / Instituto Superior de Educación Física , Uruguay
Nivel de formación: Grado

Nombre: Relación entre la asimetría de fuerza entre miembros inferiores y la velocidad en sprints lineales y cambios de dirección en jugadores de fútbol. Alumno: Sebastián Canale, Lucas Italiano, Bruno López, Agustín Yauza

Licenciatura en Educación Física (2021)

Jurado de mesa de evaluación de tesis
Sector Educación Superior/Público / Universidad de la República / Instituto Superior de Educación Física , Uruguay
Nivel de formación: Grado
Nombre: Relaciones entre los perfiles fuerza-velocidad y los diferentes puestos del seleccionado masculino U20 de rugby uruguayo. Alumnos: Romina Emed, Valentina Pallas, Nicolás Perdomo Pablo Pérez-Ifrán, Maximiliano Rial

Licenciatura en Educación Física (2021)

Jurado de mesa de evaluación de tesis
Sector Educación Superior/Público / Universidad de la República / Instituto Superior de Educación Física , Uruguay
Nivel de formación: Grado
Nombre: Impacto del uso de videojuegos de inmersión corporal sobre las capacidades coordinativas, variables fisiológicas y percepción del esfuerzo, en personas adultas con bajos niveles de actividad física semanal. Alumno: Santiago Deminco, Florencia Pintos, Valentina Vargas

Licenciatura en Educación Física (2020)

Jurado de mesa de evaluación de tesis
Sector Educación Superior/Público / Universidad de la República / Centro Universitario Regional Litoral Norte , Uruguay
Nivel de formación: Grado
Nombre: Economía electromiográfica en la carrera de adultos mayores. Alumno: Rubén Fernando Barres Berrondo

Formación de RRHH

TUTORÍAS CONCLUIDAS

GRADO

Respuestas psicológicas agudas de diferentes protocolos de entrenamiento de alta intensidad aplicados con un bajo volumen en condiciones de mundo real en adultos jóvenes (2020 - 2021)

Tesis/Monografía de grado
Sector Educación Superior/Público / Universidad de la República / Instituto Superior de Educación Física , Uruguay
Programa: Licenciatura en Educación Física
Tipo de orientación: Tutor único o principal
Nombre del orientado: Erika Mayr, Lucia Silva
País: Uruguay

Respuestas fisiologicas agudas de diversos enfoques de entrenamiento de alta intensidad aplicados con bajo volumen en situación de mundo real con adultos jóvenes (2020 - 2021)

Tesis/Monografía de grado
Sector Educación Superior/Público / Universidad de la República / Instituto Superior de Educación Física , Uruguay
Programa: Licenciatura en Educación Física
Tipo de orientación: Tutor único o principal
Nombre del orientado: Emiliano San Martin, Agustín Pioli, Mathias Ipata
País: Uruguay

OTRAS

Análise do perfil físico e antropométrico dos atletas de goalball da equipe UNIACE-DF (2016 - 2016)

Otras tutorías/orientaciones
Sector Extranjero/Internacional/Otros / Universidade Católica de Brasilia / Escola de Saúde , Brasil
Programa: Lato Sensu em Fisiologia do Exercício

Tipo de orientación: Cotutor en pie de igualdad (Benítez-Flores, S , Boullosa, DA)
Nombre del orientado: Gabriel Goulart
País: Brasil

TUTORÍAS EN MARCHA

POSGRADO

Comparación de los efectos clínicos, fisiológicos y físicos del entrenamiento funcional de alta Intensidad y el entrenamiento concurrente como modalidades de ejercicio en la rehabilitación cardíaca postinfarto (2024)

Tesis de maestria
Sector Educación Superior/Público / Programa de Desarrollo de las Ciencias Básicas / Área Biología (PEDECIBA) / Área Fisiología , Uruguay
Programa: Maestría en Biología
Tipo de orientación: Cotutor
Nombre del orientado: Darío Trujillo-Baameiro
País/Idioma: Uruguay,

Efectos clínicos, fisiológicos y metabólicos del entrenamiento funcional de alta intensidad (HIFT) como modalidad de ejercicio en un programa de rehabilitación cardíaca de mujeres con disfunción microvascular coronaria (2023)

Tesis de maestria
Sector Educación Superior/Público / Programa de Desarrollo de las Ciencias Básicas / Área Biología (PEDECIBA) / Área Fisiología , Uruguay
Programa: Maestría en Biología
Tipo de orientación: Cotutor
Nombre del orientado: Diego Ferraro-Farro. Becario ANII posgrados nacionales
País/Idioma: Uruguay,

Otros datos relevantes

PREMIOS, HONORES Y TÍTULOS

Beca para cooperación en el programa Horizonte 2020 (2015)

(Nacional)
Ministerio de Educación y Cultura
El objetivo es promover la colaboración entre grupos de I+D+I, con vistas a la participación en el Programa Horizonte 2020, en las Plataformas Tecnológicas Europeas (ETPs), en las Iniciativas Tecnológicas Conjuntas (JTIs) o en las Alianzas Público- Privadas (PPPs). Dicha convocatoria se enmarca dentro de los objetivos de Uruguay INNOVA, proyecto bilateral Uruguay/Unión Europea

PRESENTACIONES EN EVENTOS

Congreso Internacional de Nutrición y Deporte INANS (2023)

Congreso
Este II Congreso Internacional INANS 2023, inició actividades el día 23 de Octubre con nuestro Precongreso el cual fue llevado a cabo, en el auditorio de la Universidad de Ciencias Médicas (UCIMED) en la Ciudad de San José, Costa Rica. Posteriormente, durante los días 24, 25 y 26 se celebró el Congreso oficial en las instalaciones del Hotel Riu Palace, Guanacaste, Costa Rica. Ambos eventos contaron con un formato híbrido (presencial y online) abordando temas de Nutrición, Nutrición Clínica, Nutrición Deportiva y Deporte. Se presentó la siguiente exposición: Adaptaciones en la salud cardiometabólica del entrenamiento funcional de alta intensidad (HIFT)
Costa Rica
Tipo de participación: Conferencista invitado
Carga horaria: 2
Nombre de la institución promotora: INANS
Alcance geográfico: Internacional

Congreso Internacional de Nutrición y Deporte INANS (2022)

Congreso
INANS celebró su 1er Congreso Internacional, reuniendo a expertos con el más alto nivel

académico de 20 Naciones de habla hispana, inglesa y portuguesa. Dicho evento fue en modalidad híbrida, cuyo objetivo fue la difusión de las últimas actualizaciones de la Nutrición y el Deporte en sus diferentes ejes. Se presentó la siguiente exposición: Aplicaciones prácticas del entrenamiento interválico de alta intensidad (HIIT), desde la teoría a la aplicación diaria
Perú
Tipo de participación: Conferencista invitado
Carga horaria: 2
Nombre de la institución promotora: INANS
Alcance geográfico: Internacional

III SIMPOSIO INTERNACIONAL LIBiAM - Fisiología Aplicada de la Clínica al Deporte (2021)

Simposio
Dicho evento reunió a los mas importantes especialistas a nivel regional de Fisiología Aplicada al Deporte. Se presentó la siguiente exposición: Adaptaciones fisiológicas del entrenamiento interválico de esprints (SIT)
Uruguay
Tipo de participación: Conferencista invitado
Carga horaria: 1
Nombre de la institución promotora: Cenur Litoral Norte, Udelar
Alcance geográfico: Local

25th Annual Congress of the ECSS (2020)

Congreso
ECSS has spread its wings globally over its 20+ years and has grown a vast international audience who are passionate about sport science. We are a non-profit scientific organisation devoted to the promotion and dissemination of multi-and interdisciplinary research in sport and exercise science. Founded in Nice, France in 1995, we have established ourselves as the leading sport science community in Europe, with a truly international demographic. The following conference was presented: Physiological and psychological responses to various high intensity regimens in outdoor environment
España
Tipo de participación: Expositor oral
Carga horaria: 1
Nombre de la institución promotora: ECSS
Alcance geográfico: Internacional

XVIII Encuentro Nacional XIII Internacional de Investigadores en Educación Física (2020)

Encuentro
El Encuentro de Investigadores en Educación Física es un evento académico que se desarrolla en el ISEF desde el año 1994. Con frecuencia bianual, el evento convoca a investigadores del campo de la educación física del país y la región, así como a estudiantes y profesionales. Este ámbito ha acompañado el desarrollo institucional de la investigación en el ISEF, posibilitando la comunicación de resultados y la reflexión sobre la producción de conocimiento en educación física. Panel Salud prácticas y políticas en Educación Física: En dicho panel se discutieron desde diferentes visiones cuál es el papel de la educación física actual en el ámbito de la salud, sumando la participación de destacados referentes locales y regionales
Uruguay
Tipo de participación: Moderador
Carga horaria: 4
Nombre de la institución promotora: ISEF, CSIC, Udelar
Alcance geográfico: Local

XVIII Encuentro Nacional XIII Internacional de Investigadores en Educación Física (2020)

Encuentro
Se presentó la siguiente exposición: Evidencias sobre enfoques actuales de ejercicio físico en el ámbito del fitness
Uruguay
Tipo de participación: Expositor oral
Carga horaria: 2
Nombre de la institución promotora: ISEF, CSIC, Udelar
Alcance geográfico: Local

GeneXus 29 (2019)

Encuentro
GeneXus 29 fue considerado uno de los eventos más grandes de América Latina de tecnología y negocios. Se presentó la siguiente exposición: Tecnologías e innovaciones en el área del ejercicio físico ¿Qué hay en la actualidad?
Uruguay
Tipo de participación: Expositor oral
Carga horaria: 2
Nombre de la institución promotora: GeneXus
Alcance geográfico: Internacional

Evidencias científicas en movimiento humano (2019)

Seminario
Este seminario fue organizado por el Laboratorio de Investigación en Biomecánica y Análisis del Movimiento (Libiam) en el marco de los 50 años del CENUR. Durante el mismo referentes nacionales e internacionales abordaron diferentes temáticas actuales de las Ciencias de Movimiento presentando las evidencias existentes. Se presentó la siguiente conferencia: Bases fisiológicas y prácticas del entrenamiento concurrente
Uruguay
Tipo de participación: Conferencista invitado
Carga horaria: 2
Nombre de la institución promotora: Cenur Litoral Norte, PEDECIBA, Udelar
Alcance geográfico: Local

Evaluación Actividad Física y Promoción de Salud (2019)

Seminario
Actividad académica con el objetivo de generar redes de I+D entre la Udelar y la Universidad de Santiago de Chile. Se presentó la siguiente exposición: Adaptaciones físicas y fisiológicas del entrenamiento interválico
Uruguay
Tipo de participación: Conferencista invitado
Carga horaria: 1
Nombre de la institución promotora: Cátedra de Medicina del Ejercicio y Deporte, Facultad de Medicina, Udelar
Alcance geográfico: Local

XVII Encuentro Nacional XII Internacional de Investigadores de Educación Física (2018)

Encuentro
Se presentó la siguiente exposición: Efectos de diferentes propuestas de ejercicio de alta intensidad en marcadores de aptitud física y salud cardiometabólica
Uruguay
Tipo de participación: Expositor oral
Carga horaria: 2
Nombre de la institución promotora: ISEF, CSIC, Udelar
Alcance geográfico: Local

XIII Semana de Educação Física Brasilia (2017)

Simposio
Mesa redonda: Treinamento da força no Basquete atual
Brasil
Tipo de participación: Panelista
Carga horaria: 4
Nombre de la institución promotora: Universidade Paulista
Alcance geográfico: Local

Semana de Educação Física Universidade Católica de Brasilia (UCB) (2016)

Encuentro
Foi apresentada a próxima exposição: Modelos atuais para treinamento de força no basquete
Brasil
Tipo de participación: Conferencista invitado
Carga horaria: 2
Nombre de la institución promotora: UCB
Alcance geográfico: Local

Ciclo de Charlas Educación Física, Deporte y Promoción de la Salud (2015)

Simposio
Se presentó la siguiente conferencia: Evidencias de los efectos del entrenamiento de la fuerza hacia la salud
Uruguay
Tipo de participación: Conferencista invitado
Carga horaria: 3
Nombre de la institución promotora: ISEF, CSIC, Udelar
Alcance geográfico: Local

XV Encuentro Nacional y X Encuentro Internacional de Investigadores en Educación Física (2014)

Encuentro
Se presentó la siguiente exposición: Beneficios del ejercicio vibratorio hacia la Salud
Uruguay
Tipo de participación: Expositor oral
Carga horaria: 1
Nombre de la institución promotora: ISEF, CSIC, Udelar
Alcance geográfico: Local

Actualizaciones profesionales para docentes del Club Biguá (2013)

Taller
Se presentó la siguiente conferencia: Evidencias y aplicaciones de la RSA (Repeated sprint ability)
Uruguay
Tipo de participación: Conferencista invitado
Carga horaria: 4
Nombre de la institución promotora: Club Biguá
Alcance geográfico: Local

IV Encuentro Nacional de Estudiantes de Educación Física (2007)

Encuentro
El encuentro busca ser un espacio académico, de integración entre todos los estudiantes de Educación Física del país. Se presentó la siguiente conferencia: Efectos fisiológicos del ciclismo indoor
Uruguay
Tipo de participación: Expositor oral
Carga horaria: 1
Nombre de la institución promotora: ISEF, Udelar
Alcance geográfico: Local

JURADO/INTEGRANTE DE COMISIONES EVALUADORAS DE TRABAJOS ACADÉMICOS

Lectura de Septiembre: The association between daily step count and all-cause and cardiovascular mortality: a meta-analysis (2023)

Candidato: Leandro Gastelu
Tipo Jurado: Otras
Benítez-Flores, S , Rivoir, S , Florio, L
Cardiología / Sector Educación Superior/Público / Universidad de la República / Hospital de Clínicas / Uruguay
País: Uruguay
Idioma: Español

CONSTRUCCIÓN INSTITUCIONAL

Desde mi inclusión al ISEF siempre participé de todas las actividades académicas que me fueron propuestas/designadas para poder apoyar el desarrollo institucional. Entre las mismas se encuentran: Responsable de 6 asignaturas diferentes, tutor de tesis de grado, co-creador de programas para asignaturas del área salud, co-creador de programas para especializaciones, evaluador de tesis de grado, evaluador para concursos docentes, desarrollador de I+D integrando alumnos de ISEF, colaborador con otras facultades y centros del interior de la Udelar, colaborador con otras universidades nacionales e internacionales, generador de cursos de formación permanente para Montevideo y el interior, co-coordinador del encuentro de investigadores.
Actualmente me encuentro enfocado en desarrollar un centro pionero público en rehabilitación cardiovascular junto al Centro Cardiovascular Universitario (Hospital de Clínicas), que permitirá la rehabilitación y la mejora en la calidad de vida de cientos de uruguayos de los sectores más vulnerables de la

población; teniendo en cuenta que las enfermedades cardiovasculares siguen siendo la principal causa de mortalidad del país. Dicho espacio se propone integrar las tres funciones universitarias (Docencia, extensión e investigación), siendo un espacio interdisciplinario que va a incluir a: médicos, educadores físicos, nutricionistas, psicólogos, enfermeros, neumocardiólogos; así como estudiantes de grado y posgrado de todas estas ramas

Información adicional

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Montevideo 30 de enero del 2024.

Dr. Gianfranco Ruggiano Dir. ISEF, Udelar:

A través de la presente me comunico para solicitar el ingreso al régimen de dedicación total de la Udelar.

Dr. Stefano Benítez-Flores

CI: 3891628-9

Extremely Low-Volume Burpee Interval Training Equivalent to 8 Minutes Per Session Improves Vertical Jump Compared with Sprint Interval Training in Real-World Circumstances

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Original Research
Journal of Strength and Conditioning Research™

Extremely Low-Volume Burpee Interval Training Equivalent to 8 Minutes Per Session Improves Vertical Jump Compared with Sprint Interval Training in Real-World Circumstances

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Abstract

Pérez-Ifrán, P, Magallanes, CA, de S. Castro, FA, Astorino, TA, and Benítez-Flores, S. Extremely low-volume burpee interval training equivalent to 8 minutes per session improves vertical jump compared with sprint interval training in real-world circumstances. *J Strength Cond Res* XX(X): 000–000, 2023—The aim of this study was to compare the cardiometabolic and physical effects of 2 time-matched high-intensity programs in a real-world environment. Forty-three active and healthy adults (sex = 31 men and 12 women; age = 27 ± 5 years; peak heart rate [HR_{peak}] = 190.7 ± 10.6 beat·min^{-1}) were randomized to 2 very low-volume protocols (~8 minutes): sprint interval training (SIT) (n = 15), burpee interval training (BIT) (n = 15), and control (CON) (n = 13). Subjects in SIT and BIT performed 5 days of 10 × 4 second "all-out" efforts with 30 seconds of recovery. Body composition, blood pressure, countermovement jump (CMJ), 10-m sprint, shuttle run test (SRT), autonomic modulation, self-efficacy, and intention were evaluated before and after training. Sprint interval training elicited a higher %HR_{peak}, energy expenditure, rating of perceived exertion category ratio 10 scale, and feeling scale than BIT ($p < 0.05$). $SRT_{distance}$ was significantly improved in SIT ($p = 0.03$, $d = 0.62$), whereas CMJ height was significantly enhanced in BIT ($p = 0.0014$, $d = 0.72$). Self-efficacy progressively worsened for SIT than for BIT as sessions increased, and significant differences were found in 5× a week frequency between protocols ($p = 0.040$, $d = 0.79$). No differences in intention to engage were detected between the regimens ($p > 0.05$). No changes were observed in body composition, blood pressure, 10-m sprint, SRT$\dot{V}O_{2max}$, or autonomic variables with training ($p > 0.05$). Results exhibit that extremely low-volume SIT improved running performance, whereas BIT increased the vertical jump.

Key Words: high-intensity interval training, high-intensity functional training, exercise prescription, cardiometabolic health, cardiovascular adaptations

Introduction

The prevalence of physical inactivity is a critical public health problem because currently, 7.2 and 7.6% of all-cause and cardiovascular deaths, respectively, are attributable to sedentary behavior (20). Moreover, physical inactivity dramatically reduces the quality of life and promotes disability and premature death because of its association with several noncommunicable diseases, including type 2 diabetes, hypertension, coronary heart disease, and several cancers (20). Paradoxically, obese individuals who are physically active and metabolically healthy (i.e., they have a high aerobic fitness i.e., maximum oxygen consumption [$\dot{V}O_{2max}$]) have a 30–50% lower risk of mortality from cardiovascular disease than obese adults with lower $\dot{V}O_{2max}$ (24). Maximum oxygen consumption is a significant predictor of the risk of all-cause mortality because an improvement equal to 3.5 ml·kg^{-1}·min^{-1} is associated with a 13 and 15% lower risk of all-cause mortality and cardiovascular events, respectively (21). In addition, a slow heart rate recovery (HRR) after exercise is established as an independent predictor of mortality (10), and heart rate variability (HRV) is inversely associated with all-cause mortality (22). Therefore, high $\dot{V}O_{2max}$ and high HR variability may mitigate the deleterious health consequences of sedentary lifestyle.

Current physical activity (PA) guidelines recommend 150–300 min wk^{-1} of moderate-intensity continuous training or 75–150 min wk^{-1} of vigorous-intensity PA to improve health status (8). However, these recommendations are not met by most adults as a large portion of the population is insufficiently active (8). Frequently, individuals report not having sufficient time to engage in PA (45), and thus, many clinicians have called for implementing more time-efficient PA programs. It is well documented that low-volume interval training promotes various physiological adaptations, including clinical (i.e., glycemic control, redox status, blood pressure, cardiac output, etc.) (2,5,40,46) and physical (i.e., $\dot{V}O_{2max}$, time trial performance, peak power output, etc.) (2,5,6,46) parameters in healthy and unhealthy adults. Interval training can be implemented using repeated submaximal efforts (high-intensity interval training [HIIT] at ≥80 of maximal HR) or "all-out" efforts (sprint interval training [SIT] at a power output ≥100% of the workload associated with $\dot{V}O_{2max}$) (40).

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Sprint interval training has been identified as a very robust method to improve outcomes related to aerobic and anaerobic metabolism (41). Nevertheless, Wingate-based SIT is impractical for nonathletic adults because it elicits severe fatigue, hyperventilation, and nausea. Nevertheless, low-volume SIT characterized by a short-interval duration (i.e., 5 seconds) and fewer number of intervals have been proposed to reduce neuromuscular fatigue and enhance contribution of oxidative metabolism while improving subject tolerance (4). Despite the attenuated volume, short sprints have been shown to induce physiological adaptations, including significant improvements in $\dot{V}O_{2max}$ and peak power output (6), in healthy adults and athletes. In addition, low-volume SIT has been shown to be effective in diabetic, prehypertensive, and obese patients in reducing the risk of cardiometabolic disease (46). Although experimental data clearly support the efficacy of low-volume SIT, the effectiveness of this approach under "real-world" conditions is controversial (46). Therefore, new studies are needed to investigate the effects of low-volume SIT with short bouts in real-world situations and potentially elucidate the best dose-response relationship to elicit physiological adaptations.

High-intensity functional training (HIFT) is a popular alternative to laboratory-based interval training because it does not require equipment and can be performed in a small space. These exercises are performed with body mass (i.e., burpees, mountain climbers, jumping jacks, etc.) and can be implemented in public environments such as parks, beaches, or sports courts. Chronic HIFT significantly enhances neuromuscular and cardiorespiratory function in clinical and healthy populations (39). For example, extremely low-volume (~8 minutes) HIFT significantly increases $\dot{V}O_{2max}$ and time to exhaustion (29,38), muscle endurance, and power (29,38) and promotes beneficial changes in body fat and lean mass (25) in healthy adults. However, a recent meta-analysis summarizing 19 studies showed no changes in cardiometabolic variables (i.e., blood pressure, fasting glucose, or lipid profile) after 4–20 weeks of HIFT (39). Furthermore, HIFT exhibited lower increases in cardiorespiratory fitness yet greater changes in neuromuscular responses than traditional aerobic exercise (39). Nevertheless, to our knowledge, no study has compared chronic responses between HIFT vs. SIT, and only 2 studies compared the acute response to each regimen (3,14). In addition, the effects of HIFT, including short "all-out" bouts on cardiorespiratory fitness and neuromuscular performance, have yet to be explored.

The purpose of this study was to compare cardiometabolic and neuromuscular adaptations to 3 weeks of field-based HIFT and SIT with identical training volume. Developing exercise protocols in real-world scenarios is crucial to improve PA adherence and bridge the gap between laboratory and field exercise prescription. We hypothesize that very low-volume HIFT will attenuate cardiorespiratory adaptations but promote greater neuromuscular effects than SIT.

Methods

Experimental Approach to the Problem

To test the study's hypothesis, we adopted a randomized controlled design including 2 experimental groups and a nontraining control group (CON). All groups performed 2 testing sessions (pre and post), and the experimental groups completed 5 very low-volume training sessions (~8 minutes) during a 3-week period. Previously, it was shown that 6 low-volume sessions of short (i.e., 5 seconds) SIT improve cardiometabolic outcomes in young adults (5), although any effect of SIT having fewer sessions is unknown. Each training session was separated by 48–72 hours of recovery. This design was developed with the aim of being ecologically valid, using low-cost tools that are easy to use. Training was performed on an indoor basketball court with constant environmental conditions. All procedures were performed by the same evaluators, and to avoid effects of the circadian cycle, all sessions were held at the same time of day (8:00–12:00 PM). The incidental PA and dietary intake were monitored throughout the experiment.

Subjects

Initially, 87 individuals contacted the primary investigator after a publicity campaign at the University of the Republic, and 55 were recruited to participate in this study. From this sample, 50 volunteers met the inclusion criteria and were subsequently enrolled in the study. The inclusion criteria were as follows: (a) being moderately physically active (≥600 MET•min wk^{-1}) according to the International Physical Activity Questionnaire (IPAQ) Spanish short version (34), (b) not consuming any nutritional supplement, drugs, or tobacco products, (c) free of risk factors associated with cardiometabolic diseases, any musculoskeletal injury, and COVID diagnosis, (d) not using any beta-blockers drugs, (e) age between 18 and 40 years, and (f) if they were women, not be pregnant, or lactating. Subsequently, the subjects were randomly allocated into 3 groups and 43 completed the study: sex = 31 men and 12 women; age = 27 ± 5 years; height = 170.6 ± 8.9 cm; peak heart rate (HR_{peak}) = 190.7 ± 10.6 beat·min^{-1}; SIT; $n = 15$; burpee interval training (BIT); $n = 15$; and CON; $n = 13$. Seven subjects dropped out of the study for several reasons (Figure 1). The subjects were instructed to maintain their incidental lifestyle (work, hours of sleep, etc.) during the experiment, abstain from consuming alcohol for 48 hours before each session, and to avoid consumption of stimulants (mate, coffee, etc.) in the mornings. They were asked to wear loose clothing, be euhydrated, and not cycle or walk to the court before each test. Before their participation, the experimental procedures, benefits, and potential risks were explained to all subjects in written and verbal forms, and subsequently, they provided written informed consent. This study was approved by the University Ethics Committee of the Higher Institute of Physical Education, University of the Republic Uruguay (No. 2/2020 and date of final approval November 4, 2020) and was conducted following the principles stipulated in the Declaration of Helsinki (https://sites.jamanetwork.com/research-ethics/index.html).

Procedures

Testing Measures. Informed consent and various questionnaires were completed at the beginning of the first day, and subsequently, the subjects performed all assessments in the following sequence: (a) body composition, (b) blood pressure, (c) familiarization, (d) vertical jump, (e) 10-m sprint, and (f) shuttle run test (SRT, Figure 1). Exercise training included 5 sessions for each group, composed of 10 "all-out" bouts of 4-second duration with 30 seconds of recovery. This protocol was used in a previous acute study (3) and was included in a meta-analysis showing significant aerobic and anaerobic adaptations in response to SIT (6). The training intensity was monitored during each session using physiological and psychological outcomes. These tests were repeated at least 72 hours after the final session of training.

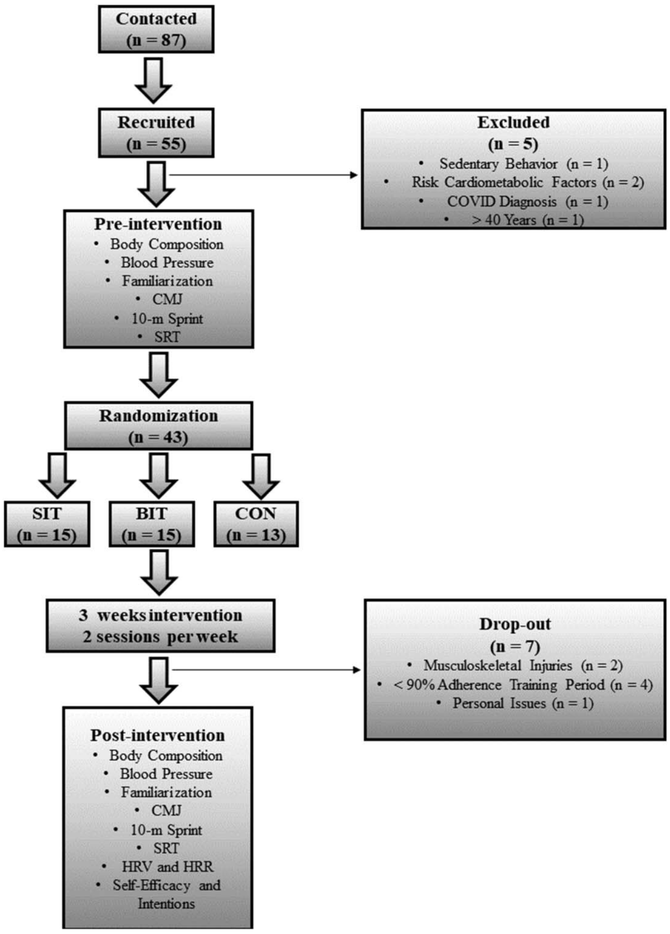

Figure 1. Study design. SIT = sprint interval training; BIT = burpees interval training; CON = control; CMJ = countermovement jump; SRT = shuttle run test; HRV = heart rate variability; HRR = heart rate recovery.

Body Composition We measured height (in centimeters) using a stadiometer (2096 PP; Toledo do Brazil, Sao Paulo, Brazil) and body mass (in kilograms), body mass index (BMI), muscle mass (%), fat mass (%), and visceral fat mass (%) using a digital body composition monitor (HBF 514C; OMRON, Kyoto, Japan). The measures were determined following previous procedures (32). To measure waist circumference (WC), the subjects assumed a relaxed standing position with the arms folded across the thorax, and WC was recorded at the level of the narrowest point between the lower costal (rib) border and the top of the iliac crest, at the end of normal expiration (32). Hip circumference (HC) was assessed at the level of the greatest posterior protuberance of the buttocks and perpendicular to the long axis of the trunk (32). Two measurements were taken with an anthropometric tape (SN-4010; Sanny Medical Starret, Sao Paulo, Brazil), using the mean value for analysis. The waist-to-hip ratio (WHR) was calculated by dividing WC and HC.

Blood Pressure Blood pressure was measured in a sitting position after 3 minutes of rest using a digital sphygmomanometer (CH-432; CITIZEN, Tokyo, Japan). This monitor has been shown to be reliable and valid to monitor blood pressure (11). The subject was seated with the arm slightly bent, the palm facing up, and the forearm supported nearly horizontal at the level of the heart. In addition, the arm was free of tight clothing that could partially occlude blood flow (16). During the test, the legs were not crossed, and any form of isometric muscle action was to be avoided, such as pressing the legs down, hanging the feet off the ground, or sitting upright with the back unsupported. We positioned the cuff on the right arm with the lower margin about 2.5 cm above the antecubital space. Throughout the measurement, the arm was extended and supported at the level of the heart (16). Two measurements were performed following these procedures with a 3-minute rest interval between the assessments, and the mean value for diastolic blood pressure (DBP) and systolic blood pressure (SBP) was used for analysis.

Familiarization All subjects performed a 3-minute warm-up of running at a self-selected pace. Then, the subjects were familiarized with vertical jump and burpees. Initially, 2 repetitions of the countermovement jump (CMJ) were completed. The subjects were instructed to rest their hands on their hips while performing a downward movement to approximately 90° of knee flexion, followed by a maximal vertical jump, keeping their legs straight during the flight phase and landing at the same take-off point (26). Familiarization with the burpees was performed according to Gist et al. (14). The subjects stood with arms at the sides, then lowered into a squat position and placed the hands on the ground in front of the feet, then kicked the feet back and initiated a push-up, returned to a squat position, and ended with a maximal jump with arms extended overhead. Approximately 5 minutes later, subjects were familiarized with SIT, which also served to provide practice for the 10-m sprint.

Countermovement Jump The CMJ is a validated and accessible method to determine lower-body power (26). The CMJ (CMJ_{height}) and absolute and relative body mass CMJ peak power ($CMJ_{powerabs}$, $CMJ_{powerrel}$) were recorded with PUSH band version 2.0 (PUSH Inc., Toronto, ON, Canada), which is valid and reliable for vertical jumps (30). The device was securely placed on the lower back with a waist belt. The average of 2 repetitions separated by 1 minute of passive recovery was analyzed.

10-m Sprint The 10-m sprint time was assessed, including 5-m split time. The subjects were instructed to run at maximum speed over a distance of 10 m, starting with the front foot 50 cm behind the starting line. Two repetitions were completed separated by passive recovery of 1 minute. Time to cover 10 m was recorded with *MySprint app* (Apple Inc., Cupertino, CA) that showed adequate validity and reliability for sprint time (35). *MySprint* was used with iPad (Apple Inc., Cupertino, CA) and was located 10 m away on a tripod, following the recommendations for measurements suggested by the creators of the APP (35). The mean of the 2 attempts was used for the analysis.

Shuttle Run Test The SRT is considered a valid approach to estimate $\dot{V}O_{2max}$ (43). The test consists of running for as long as possible between 2 lines separated by 20 m with a rhythm imposed by audio. The test starts with an initial speed equivalent to 8.5 $km \cdot h^{-1}$ and has increments equal to 0.5 $km \cdot h^{-1}$ every minute. The end of the test is determined when the 20-m distance cannot be covered in 2 consecutive efforts. To estimate $\dot{V}O_{2max}$, the equation proposed by Stickland et al. (43) was used: Men $\dot{V}O_{2max} = 2.75 \times$ [last half-stage complete] + 28.8; Women $\dot{V}O_{2max} = 2.85 \times$ [last half-stage complete] + 25.1). Also, HR_{peak} was recorded by employing chest straps through a telemetric system (Firstbeat Sports software version 4.7.3.1; Firstbeat Technologies Ltd., Jyväskylä, Finland). All subjects were verbally encouraged to exercise to exhaustion, and we used 2 criteria to classify the effort as maximum: (a) peak HR ≥90% of the age-predicted maximum (208 − [0.7 × age]); and (b) visible exhaustion. All subjects were verbally encouraged to exercise to exhaustion.

Dietary Intake During the training period, subjects tracked their dietary intake for 2 random days including 1 week day and 1 weekend day. A dietician instructed subjects how to complete the food diary and analyzed the information concerning total kcals, % carbohydrates, % proteins, and % fats. These data were analyzed using a custom-software MyFitnessPal (MyFitnessPal, Inc., San Francisco, CA) (44).

Incidental Physical Activity The incidental PA was assessed in all groups using IPAQ Spanish short version. This questionnaire was applied on the first and the last day of training to assess the PA done during the last week. It has adequate validity to quantify PA levels in young adults in contrast to accelerometry (34). The variables compared included (a) $Kcal \cdot wk^{-1}{}_{total}$; (b) $Kcal \cdot wk^{-1}{}_{vigorous}$; (c) $Kcal \cdot wk^{-1}{}_{moderate}$; and (d) $Kcal \cdot wk^{-1}{}_{walking.}$

Intervention Group Measures.

Interval Training Sessions Initially, subjects ran for 3 minutes at a self-selected pace. Total duration of each session was 5 minutes 10 seconds, and total exercise time was 40 seconds. Sprint interval training and BIT were equal in relation to the type of effort ("all-out"), type of stimulus (multijoint), and work-to-recovery ratio. Passive recovery was accomplished for both interventions, given that this type of rest was well tolerated across running-based SIT and BIT (28). During SIT, subjects were instructed to run as fast as they could, and after recovery, subjects were asked to run in the opposite direction. During BIT, subjects were encouraged to perform as many repetitions per interval as possible while maintaining correct technique. Burpees are a widely used exercise within HIFT routines; however, their unique longitudinal effects have not yet been revealed (39). Both regimens were monitored by a mobile application that provides audible alerts for each series (10 × 4-second work and 30 seconds of recovery). Heart rate data were collected with a telemetric system (Firstbeat Sports software version 4.7.3.1; Firstbeat Technologies Ltd., Jyväskylä, Finland) that is valid and reliable (33), to describe internal load represented as the HR_{mean} and percentage of heart rate peak ($\%HR_{peak}$). Also, rating of perceived exertion category ratio 10 scale (CR-10 RPE) was used because it is designed to estimate the intensity of exercise, and it strongly correlated with HR (13). This instrument is graduated numerically from 0 to 10, with 0–2 ratings deemed easy effort, 3–6 ratings moderate to hard effort, and 7–10 ratings hard to maximum effort (13). This scale shows validity and good reliability for men and women (15). In addition, the feeling scale (FS), a psychometric tool that describes affective valence and emotional aspects of the exercise experience, focusing on the pleasure-displeasure dichotomy (17) was used to assess affective valence. This scale was validated in physically active individuals (1). The FS contains values from +5 to −5 (+5 equal "very good" and −5 represents "very bad"). Both scales were recorded immediately post-exercise. The physiological and psychological outcomes were recorded during the first, second, fourth, and fifth training sessions. Throughout the sessions, the researchers provided strong verbal encouragement for subjects to achieve maximum effort in each interval.

Heart Rate Variability and Heart Rate Recovery To assess the impact of the exercise protocols on autonomic balance, we analyzed the response of the HRV and HRR. Subjects remained in a supine position, which showed more reliability than other positions (7), and completed 2-minute records pre and post exercise in session first, second, fourth, fifth. They were requested to breathe normally and avoid any movements throughout data acquisition. To assess HRV, we analyzed only the second minute of recording (baseline and end for each session) because the first minute is considered a stabilization period during resting. This approach can assess autonomic function accurately in field environments and is easily applied during training routine (12). The variables selected were the R-R intervals and the root mean square of successive differences between R-R intervals (RMSSD), which is recognized as the strongest indicator of parasympathetic modulation (7). In addition, this parameter is not influenced by breathing frequency and can measure parasympathetic tone in a short period (7). Furthermore, the HRR was evaluated and defined as the difference between HR at the end of exercise (HR_{end}) and after 60 and 120 seconds of recovery ($\Delta HR_{end\text{-}60s\ end}$, $\Delta HR_{end\text{-}120s\ end}$). Also, we assessed the differences between baseline HR (HR_{bas}), and HR_{end} ($\Delta HR_{bas\text{-}end}$), 60 and 120 seconds ($\Delta HR_{bas\text{-}60s\ end}$, $\Delta HR_{bas\text{-}120s\ end}$).

Exercise Task Self-Efficacy and Intentions After the last training session, subjects' confidence to repeat the exercise protocol completed at different frequency per week (i.e., 1× a week to 5× a week) was assessed using a 5-item scale (19). Each question included the stem, "How confident are you that you can…". The 5-items were as follows: (a) "perform one bout of exercise a week for the next 4 weeks that is just like the one you completed today?"; (b) "perform two bouts of exercise a week for the next 4 weeks that is just like the one you completed today?"; (c) "perform three bouts of exercise a week for the next 4 weeks that is just like the one you completed today?"; (d) "perform four bouts of exercise a week for the next 4 weeks that is just like the one you completed today?"; (e) "perform five bouts of exercise a week for the next 4 weeks that is just like the one you completed today?". Responses were scored on a scale of 0% (not at all) to 100% (extremely confident) in 10% increments. Previously, the instrument demonstrated good internal consistency (α's > 0.95) (19). Moreover, we asked the subjects regarding their ability to repeat the exercise using a 5-item measure, and the subjects' intentions to engage in the training regimens performed in the future at rates of 3 times or 5 times a week (intention 3× a week or intention 5× a week) over the next month (19). Specifically, subjects were asked "Please rate the extent to which you agree with the following statements": (a) "I intend to engage in the type of exercise I performed today at least 3 times per week during the next month", (b) "I intend to engage in the type of exercise I performed today at least 5 times per week during the next month." The scores were registered using a Likert-type 7-point scale, ranging from 1 (very unlikely) to 7 (very probable).

Statistical Analysis

A priori power analysis through G*Power 3.1.9.7 (Dusseldorf University, Dusseldorf, Germany) was used to determine the required sample size to detect a change in $\dot{V}O_{2max}$, considering the following input parameters: repeated-measures analysis of variance (ANOVA; within-between interaction), effect size $f = 0.25$; $\alpha = 0.05$; statistical power = 0.80, 3 groups, 4 measurements, correlation among repeated measures 0.4. The required sample size was 12 in each group, which was met in this study.

Descriptive statistics (mean ± *SD* and lower and upper limits—95%—of the confidence intervals) were calculated. Data normality was not tested because ANOVA is robust to normality infractions (36). Otherwise, when Student's t tests were applied, data normality was verified with Shapiro-Wilk test. To verify test reliability, intraclass correlation coefficients (ICC, 2-way mixed model for consistency analysis) were applied for WC, HC, SBP, DPB, $CMJ_{powerabs}$, $CMJ_{powerrel}$, and 5- and 10-m sprint time. To compare the baseline parameters between SIT, BIT, and CON, and dietary intake across SIT, BIT, and CON, 1-way ANOVA was applied. The Levene's test and the post hoc test (Bonferroni's if Levene's test result >0.05 and Tamhane's if Levene's test result <0.05) were executed.

To compare incidental PA, cardiometabolic, and physical parameters among SIT, BIT, and CON, a mixed, repeated-measures, 2 × 3 ANOVA (time and groups) was applied. To compare perceptual and heart rate response during training between SIT and BIT, a mixed, repeated-measures, 4 × 2 ANOVA (sessions and groups) was applied. To compare intentions between SIT and BIT, we used a mixed, repeated-measures, 2 × 2 ANOVA (intentions and groups). To compare self-efficacy between SIT and BIT groups, a mixed, repeated-measures, 5 × 2 ANOVA (bouts of exercise and groups) was applied. In all factorial ANOVAs, the main effects (with Bonferroni's post hoc test, when necessary) and interaction between factors were analyzed. When interactions were significant, splits were performed (1-way ANOVA, with Bonferroni's post hoc test, when necessary, and Student's *t* test for dependent data). In all repeated and factorial ANOVAs, Mauchly's test identified the sphericity. When sphericity was not assumed, the Greenhouse-Geisser Epsilon correction was used. Training response, between SIT and BIT, was compared with independent *t* test.

To verify the effects sizes, partial eta-squared (η^2) and Cohen' *d* tests were performed. Interpretation of η^2 indicates small ($\eta^2 \geq 0.02$), medium ($\eta^2 \geq 0.13$), or large ($\eta^2 \geq 0.26$) effect sizes for a 2-way ANOVA and small ($\eta^2 \geq 0.01$), medium ($\eta^2 \geq 0.06$), or large ($\eta^2 \geq 0.14$) effect sizes for 1-way ANOVA. Interpretation of Cohen's *d* indicates 0–0.19 trivial, 0.2–0.59 small, 0.6–1.19 moderate, 1.2–1.99 large, 2.0–3.99 very large, and >4.0 nearly perfect (9). The overall alpha level was set at $p < 0.05$. However, in the ANOVAs, the significance level was corrected for the number of comparisons, using the Bonferroni's correction factor. All analyses were performed with IBM SPSS version 23.0 (Armonk, NY).

Results

Reliability

Intraclass correlation coefficients were equal to 0.99, 0.86, 0.86, 0.86, 0.98, 0.96, 0.95, and 0.98, respectively, for WC, HC, SBP, DPB, $CMJ_{powerabs}$, $CMJ_{powerrel}$, and 5- and 10-m sprint time (all $p < 0.001$).

Dietary Intake and Incidental Physical Activity in All Groups

Total energy intake was equal to 1,252.0 ± 414.5 [816.9–1,687.0], 1,244.3 ± 466.3 [986.0–1,502.6], and 1,133.0 ± 276.3 [966.0–1,300.0] kcal for SIT, BIT, and CON, respectively ($F = 0.33$, $p = 0.71$, $\eta^2 = 0.02$). Carbohydrate intake was equal 48.2 ± 9.7 [42.8–53.6], 48.0 ± 6.5 [44.4–51.6], and 45.2 ± 8.4 [40.0–50.3] % for SIT, BIT, and CON, respectively ($F = 0.55$, $p = 0.57$, $\eta^2 = 0.002$) Fat intake did not differ across the 3 groups was 18.2 ± 4.0 [16.0–20.4], 17.8 ± 2.8 [16.3–19.4], and 17.6 ± 3.1 [15.7–19.6] % for SIT, BIT, and CON ($F = 0.087$, $p = 0.91$, $\eta^2 = 0.004$). Protein intake was not significantly different among groups: 32.0 ± 9.5 [26.7–37.3], 34.0 ± 5.9 [30.8–37.5], and 35.5 ± 9.9 [29.5–41.5] % for SIT, BIT, and CON ($F = 0.58$, $p = 0.56$, $\eta^2 = 0.02$).

No time × group interaction was detected for total PA kcals ($F = 0.33$, $p = 0.71$, $\eta^2 = 0.021$): pre-SIT 3,993.6 ± 3,046.3 [2,306.6–5,680.7] and post-SIT 2,680.1 ± 2,065.9 [512.0–4,848.1], pre-BIT 5,111.3 ± 3,053.9 [3,420.1–6,802.6] and post-BIT 4,897.6 ± 3,067.4 [3,199.0–6,596.3], pre-CON 2,946.3 ± 1,675.2 [1,934.0–3,958.7] and post-CON 3,508.0 ± 2,000.6 [2,299.0–4,716.9].

Compliance to Training in Intervention Groups

Four subjects dropped out (2 women and 2 men) for not attending >90% of training sessions (Figure 1), and 1 dropped out for personal reasons. One man and 1 woman dropped out of the study because of musculoskeletal injuries (biceps femoris and rectus femoris tear, respectively) experienced during the SIT intervention. Fainting episodes, respiratory events, nausea, dizziness, and vomiting were not observed.

Training Response in Intervention Groups

During SIT, the subjects covered approximately 25-m each running bout. The training response was examined by considering the average value across the 4 sessions for each regimen. The variables analyzed were as follows: (a) adherence; (b) $\%HR_{peak}$; (c) energy expenditure; (d) CR-10 RPE; and (e) FS. Adherence % was not different between the groups (SIT = 93.3 ± 9.8 [87.9–98.3], BIT = 96.0 ± 8.3 [91.4–100.5], $t = -0.80$, $p = 0.42$, $d = 0.29$). Data show significant differences between the groups for $\%HR_{peak}$ (SIT = 83.2 ± 3.9 [81.1–85.3], BIT = 72.5 ± 9.2 [67.3–77.5], $t = 4.19$, $p < 0.001$, $d = 1.51$), energy expenditure (kcals) (SIT = 63.9 ± 13.4 [56.4–71.3], BIT = 47.5 ± 16.3 [38.5–56.9], $t = 2.99$, $p = 0.006$, $d = 1.09$), CR-10 RPE (SIT = 4.8 ± 1.8 [3.8–5.7], BIT = 2.6 ± 0.9 [2.0–3.0], $t = 4.27$, $p < 0.001$, $d = 1.55$), and FS (SIT = 2.7 ± 1.3 [2.0–3.4], BIT = 3.6 ± 1.0 [3.0–4.2], $t = -3.23$, $p = 0.002$, $d = 0.77$).

Changes in Cardiometabolic Parameters in All Groups

For body mass, BMI, muscle mass, fat mass, WC, HC, WHR, SBP, and DBP, no time × group interaction was detected ($p > 0.05$, $\eta^2 \leq 0.12$). Yet, a significant time × group interaction was noted for visceral fat mass ($p = 0.047$, $\eta^2 = 0.14$), and post hoc analysis showed that it was significantly reduced in response to BIT ($p = 0.05$, $d = 0.54$) compared with pretraining (Table 1).

Changes in Physical Parameters in all Groups

For $CMJ_{powerabs}$, $CMJ_{powerrel}$, 5-m sprint time, 10-m sprint time, $SRT_{Velocity}$, and $SRT\dot{V}O_{2max}$, results showed no time × group interaction ($p > 0.05$, $\eta^2 \leq 0.11$). However, there was a significant time × group interaction for CMJ_{height} ($p = 0.02$, $\eta^2 = 0.16$), and the post hoc analysis denoted higher CMJ_{height} in response to BIT ($p = 0.0014$, $d = 0.72$). Even though the improvement of CMJ height seems to be similar between BIT and CON, it should be noted that the coefficient of variation in CON (21.3%) was higher than in BIT (14.7%). Also, data exhibited a significant time × group interaction for $SRT_{distance}$ ($p = 0.02$, $\eta^2 = 0.17$), and pairwise comparisons showed an increased $SRT_{distance}$ in response to SIT ($p = 0.03$, $d = 0.62$) (Table 1).

Changes in Perceptual and Heart Rate Response in Intervention Groups

No time × group interaction for FS, CR-10 RPE, HR_{bas}, HR_{mean}, $\%HR_{peak}$, Kcals, HR_{end}, $HR_{60s\ end}$, $HR_{120s\ end}$, $RMSSD_{bas}$, $RMSSD_{end}$, R-R_{bas}, or R-R_{end} was detected during the training sessions ($p > 0.05$, $\eta^2 \leq 0.05$; Table 2). In addition, no time × group interaction was noted for change scores for $\Delta HR_{end\text{-}60s\ end}$, $\Delta HR_{end\text{-}120s\ end}$, $\Delta HR_{bas\text{-}end}$, $\Delta HR_{bas\text{-}60s\ end}$, $\Delta HR_{bas\text{-}120s\ end}$, $\Delta RMSSD_{bas\text{-}end}$, and ΔR-$R_{bas\text{-}end}$ during the training sessions ($p > 0.05$, $\eta^2 \leq 0.029$; Table 3).

Changes in Self-Efficacy and Intention Response in Intervention Groups

A significant frequency × group interaction was observed for self-efficacy after the training sessions ($F = 5.10$, $p = 0.032$, $\eta^2 = 0.15$). For SIT, the response was 93.3 ± 9.0 [88.3–98.3] for 1× a week, 84.0 ± 25.5 [69.8–98.1] for 2× a week, 73.3 ± 29.9 [56.7–98.1] for 3× a week, 58.0 ± 31.8 [40.3–75.6] for 4× a week, and 48.6 ± 29.9 [32.0–65.2] for 5× a week. For BIT, the response was 94.0 ± 8.2 [89.4–98.5] for 1× a week, 90.0 ± 15.1 [81.6–98.3] for 2× a week, 84.0 ± 19.9 [72.9–95.0] for 3× a week, 77.3 ± 23.4 [64.3–90.3] for 4× a week, and 71.3 ± 27.4 [56.1–86.5] for 5× a week. Significant intragroup differences were exhibited for SIT between 1× a week, 2× a week, and 3× a week vs. 4× a week, and 5× a week ($p < 0.05$, $d \leq 2.02$). Also, a significant intragroup difference was found for SIT between 4× a week vs. 5× a week ($p = 0.021$, $d = 0.30$). A significant intragroup difference was observed for BIT between 1× a week vs. 5× a week ($p = 0.034$, $d = 1.12$) and 2× a week vs. 4× a week and 5× a week ($p < 0.05$, $d \leq 0.84$). For the intergroup comparisons, the only difference was noted in 5× a week frequency, which being higher in BIT vs. SIT ($p = 0.040$, $d = 0.79$).

No intention × group interaction was detected for intention after the training sessions ($F = 0.43$, $p = 0.51$, $\eta^2 = 0.015$): intention 3× a week (SIT = 5.80 ± 1.26 [5.10–6.50], BIT = 5.27 ± 1.43 [4.47–6.06]), intention 5× a week (SIT = 4.07 ± 2.01 [2.95 to 5.18], BIT = 3.80 ± 1.61 [2.91 to 4.69]).

Discussion

This study is the first to compare cardiometabolic and physical adaptations to extremely low-volume HIFT (i.e., including only burpees, BIT) vs. SIT in real-world circumstances. During training, SIT elicited a greater physiological (i.e., $\%HR_{peak}$) and psychological (i.e., CR-10 RPE, and FS) response vs. BIT. Results showed that only 5 sessions of BIT consisting of 120 seconds of exercise per week was sufficient to improve vertical jump height. Furthermore, very low-volume SIT significantly improved total distance covered in SRT. Nevertheless, no changes were observed in body composition, blood pressure, 10-m sprint, $\dot{V}O_{2max}$, or autonomic balance variables. Finally, the self-efficacy was progressively worse for SIT than for BIT as sessions increased. Our initial hypothesis was met given that HIFT improved neuromuscular performance without changes in cardiorespiratory fitness compared with SIT.

Prior research suggests that low-volume interval training improves glycemic control, antioxidant status, and $\dot{V}O_{2max}$ in healthy and unhealthy adults (2,5,6,39,40,46). A novel strategy to improve $\dot{V}O_{2max}$ is reducing the metabolic stress of traditional SIT using shorter efforts (6). For example, Hazell et al. (18) noted similar changes in power output, time trial performance, and $\dot{V}O_{2max}$ in response to 6 sessions of short (i.e., 10 seconds) vs. long bouts (i.e., 30 seconds) of SIT. Vollaard and Metcalfe (46) reported that 18 sessions of two 10–20 seconds sprints across a 10-minute session induce improvements in $\dot{V}O_{2max}$ (+12%) and insulin sensitivity in sedentary young adults. Benítez-Flores et al. (5) showed that 6–12 "all-out" 5-second bouts applied over 6 sessions, requiring only approximately 13 minutes of training, improved $\dot{V}O_{2max}$ (+7%) similar to subjects performing SIT or SIT combined with strength training in young healthy adults. In addition, Schaun et al. (38) demonstrated that 16 weeks of SIT consisting of eight 20 seconds efforts at 130% $\dot{V}O_{2max}$ similarly increased time to exhaustion and $\dot{V}O_{2max}$ vs. HIFT. Our study used 4-second bouts, and data show that SIT did not alter $\dot{V}O_{2max}$ yet significantly enhanced distance during SRT, representing a moderate effect ($d = 0.62$, +5%). This improvement is substantial given the high baseline $\dot{V}O_{2max}$ (i.e., >52 $ml\cdot kg^{-1}\cdot min^{-1}$) of our subjects. The findings corroborate those in a recent meta-analysis in which HIFT was found to attenuate increases in cardiorespiratory fitness than traditional aerobic exercise (39). These outcomes may be associated with the lower $\%HR_{peak}$ for BIT than for SIT observed in this study (Table 2) and a prior study (3). In addition, prior work shows peripheral adaptations in skeletal muscle related to the improved mitochondrial function, such as

Table 1

Cardiometabolic and physical parameters.*†

	Pretime			Posttime			Group effect	Time effect	Time vs. Group
Variable	SIT	BIT	CON	SIT	BIT	CON	F; p; η^2	F; p; η^2	F; p; η^2
Body mass (kg)	71.7 ± 11.7 (65.2–78.1)	70.3 ± 8.7 (65.4–75.1)	71.0 ± 16.2 (61.2–80.8)	71.3 ± 10.8 (65.3–77.3)	69.1 ± 8.7 (64.3–74.0)	70.9 ± 15.5 (61.5–80.3)	0.13; 0.87; 0.006	4.75; 0.035§; 0.10	1.49; 0.23; 0.06
BMI (kg·m^{-2})	24.0 ± 1.9 (22.9–25.1)	24.5 ± 2.4 (23.1–25.8)	24.3 ± 3.0 (22.4–26.1)	23.9 ± 2.1 (23.0–24.9)	23.9 ± 2.1 (22.7–25.0)	24.2 ± 2.8 (22.5–25.9)	0.042; 0.95; 0.002	5.11; 0.029§; 0.11	2.58; 0.88; 0.11
Muscle mass (%)	36.1 ± 7.9 (31.7–40.4)	34.4 ± 6.2 (30.9–37.9)	33.8 ± 5.5 (30.4–37.1)	35.7 ± 8.2 (31.1–40.3)	35.3 ± 6.4 (31.7–38.9)	33.7 ± 5.7 (30.2–37.2)	0.77; 0.46; 0.035	0.38; 0.53; 0.01	2.23; 0.12; 0.10
Fat mass (%)	22.6 ± 7.2 (18.6–26.6)	27.2 ± 7.5 (23.1–31.4)	27.3 ± 5.9 (23.7–30.9)	22.5 ± 6.7 (18.8–26.3)	25.5 ± 7.5 (21.3–29.7)	27.4 ± 6.3 (23.6–31.2)	2.88; 0.067; 0.11	2.02; 0.16; 0.04	2.25; 0.11; 0.10
Visceral fat mass (%)	6.1 ± 1.6 (5.1–6.9)	6.6 ± 2.5 (5.1–8.0)	6.6 ± 3.0 (4.7–8.4)	6.0 ± 1.3 (5.2–6.7)	5.8 ± 2.0 (4.7–7.0)	6.6 ± 3.2 (4.7–8.6)	0.08; 0.92; 0.004	3.03; 0.08; 0.07	3.29; 0.047‖; 0.14
WC (cm)	76.7 ± 6.4 (73.1–80.3)	76.7 ± 5.7 (73.5–79.9)	76.4 ± 11.0 (69.7–83.1)	76.1 ± 5.6 (73.0–79.3)	76.6 ± 6.0 (73.2–79.9)	75.9 ± 10.9 (69.3–82.5)	0.058; 0.94; 0.003	3.63; 0.06; 0.083	0.42; 0.65; 0.02
HC (cm)	97.8 ± 5.1 (95.0–100.6)	99.5 ± 5.5 (96.4–102.5)	98.3 ± 8.0 (93.4–103.1)	98.0 ± 5.0 (95.2–100.8)	98.5 ± 4.7 (95.9–101.1)	97.9 ± 6.9 (93.7–102.1)	0.16; 0.85; 0.007	1.20; 0.27; 0.029	0.98; 0.38; 0.04
WHR	0.78 ± 0.05 (0.75–0.81)	0.77 ± 0.03 (0.74–0.79)	0.77 ± 0.07 (0.72–0.81)	0.77 ± 0.04 (0.75–0.80)	0.77 ± 0.04 (0.75–0.80)	0.77 ± 0.07 (0.72–0.81)	0.40; 0.66; 0.019	0.25; 0.61; 0.006	1.29; 0.28; 0.06
SBP (mm Hg)	124.9 ± 6.5 (121.3–128.5)	128.2 ± 10.1 (122.6–133.9)	135.8 ± 13.9 (127.4–144.2)	124.2 ± 7.3 (120.1–128.2)	126.8 ± 9.5 (121.5–132.1)	129.4 ± 11.3 (122.5–136.2)	1.43; 0.24; 0.063	5.96; 0.01§; 0.13	2.23; 0.12; 0.10
DPB (mm Hg)	74.7 ± 7.4 (70.6–78.8)	76.9 ± 6.1 (73.5–80.3)	83.9 ± 8.5 (78.7–89.0)	76.5 ± 8.3 (71.9–81.1)	75.4 ± 6.4 (71.8–79.0)	79.5 ± 9.4 (73.8–85.2)	2.44; 0.09; 0.10	1.72; 0.19; 0.04	2.91; 0.06; 0.12
CMJ_{height} (cm)	37.3 ± 7.1 (33.4–41.3)	33.1 ± 5.6 (30.0–36.3)	34.5 ± 5.7 (31.0–38.0)	36.5 ± 6.6 (32.8–40.2)	34.4 ± 6.2 (31.0–38.0)	36.0 ± 7.7 (31.3–40.7)	1.40; 0.25; 0.061	2.82; 0.10; 0.06	3.95; 0.02‖; 0.16
$CMJ_{powerabs}$ (W)	3,179.5 ± 537.3 (2,882.0–3,477.1)	3,225.3 ± 605.1 (2,890.1–3,560.4)	2,999.7 ± 438.5 (2,734.7–3,264.7)	3,334.5 ± 591.8 (3,006.7–3,662.2)	3,279.3 ± 567.5 (2,965.0–3,593.5)	3,298.4 ± 552.4 (2,964.5–3,632.2)	0.56; 0.57; 0.026	10.8; 0.002§; 0.21	1.86; 0.16; 0.08
$CMJ_{powerrel}$ (W·kg^{-1})	45.3 ± 9.7 (40.0–50.7)	46.2 ± 9.2 (41.1–51.4)	44.1 ± 11.0 (37.4–50.8)	47.8 ± 10.8 (41.8–53.8)	47.7 ± 8.4 (43.0–52.4)	48.7 ± 13.6 (40.4–57.0)	0.079; 0.92; 0.004	12.6; 0.001§; 0.24	1.28; 0.28; 0.06
5-m sprint time (s)	1.18 ± 0.08 (1.14–1.23)	1.23 ± 0.08 (1.19–1.28)	1.28 ± 0.12 (1.21–1.36)	1.16 ± 0.07 (1.12–1.20)	1.18 ± 0.08 (1.14–1.23)	1.27 ± 0.10 (1.21–1.33)	6.43; 0.004‡; 0.23	7.49; 0.009§; 0.15	1.24; 0.30; 0.05
10-m sprint time (s)	2.00 ± 0.15 (1.92–2.09)	2.08 ± 0.14 (2.00–2.16)	2.15 ± 0.18 (2.04–2.27)	1.97 ± 0.12 (1.91–2.04)	2.02 ± 0.15 (1.93–2.11)	2.14 ± 0.16 (2.03–2.24)	4.94; 0.012‡; 0.18	7.72; 0.008§; 0.16	0.80; 0.45; 0.03
$SRT_{velocity}$ (km·h^{-1})	12.8 ± 1.09 (12.2–13.4)	12.6 ± 1.00 (12.0–13.9)	12.5 ± 0.97 (11.9–13.0)	13.0 ± 1.07 (12.4–13.6)	12.6 ± 1.09 (12.0–13.2)	12.3 ± 0.96 (11.8–12.9)	1.45; 0.24; 0.063	0.24; 0.62; 0.006	2.86; 0.08; 0.11
$SRT\dot{V}O_{2max}$ (ml·kg^{-1}·min^{-1})	54.5 ± 7.2 (50.5–58.5)	53.4 ± 6.6 (49.7–57.1)	52.6 ± 6.4 (48.7–56.7)	55.7 ± 7.0 (51.8–59.7)	53.4 ± 7.0 (49.5–57.4)	52.0 ± 6.4 (48.0–55.8)	1.22; 0.30; 0.054	0.24; 0.62; 0.006	2.69; 0.08; 0.11
$SRT_{distance}$ (m)	1,628.0 ± 451.7 (1,377.8–1,878.1)	1,544 ± 417.9 (1,312.5–1,775.4)	1,504.6 ± 396.6 (1,264.9–1,744.3)	1,709.3 ± 461.0 (1,454.0–1,964.6)	1,553.3 ± 454.9 (1,301.3–1,805.2)	1,438.4 ± 368.8 (1,215.5–1,661.3)	1.37; 0.26; 0.16	0.15; 0.69; 0.004	4.18; 0.02‖; 0.17

*SIT = sprint interval training; BIT = burpees interval training; CON = control; BMI = body mass index; WC = waist circumference; HC = hip circumference; WHR = waist-to-hip ratio; SBP = systolic blood pressure; DBP = diastolic blood pressure; CMJ_{height} = countermovement jump height; $CMJ_{powerabs}$ = countermovement jump peak power absolute; $CMJ_{powerrel}$ = countermovement jump peak power relative; $SRT_{velocity}$ = shuttle run test velocity; $SRT\dot{V}O_{2max}$ = shuttle run test maximum oxygen consumption; $SRT_{distance}$ = shuttle run test distance.

†Data are expressed as mean ± *SD* and limits of the mean confidence interval (95%).

‡Significant group effect.

§Significant time effect.

‖Significant interactions between the factors; splits were performed: (a) visceral fat mass (%): analysis of group effects in the pretime and posttime, respectively: $F = 0.23$, $p = 0.23$, $\eta^2 = 0.01$ and $F = 0.50$, $p = 0.60$, $\eta^2 = 0.15$, respectively. Analysis of the effects of time in each group SIT, BIT, and CON, respectively: $t = 0.43$, $p = 0.67$, $d = 0.11$; **$t = 2.120$, $p = 0.05$, $d = 0.54$**; $t = -0.56$, $p = 0.58$, $d = 0.15$. (b) CMJ_{height} (cm): analysis of group effects in the pretime and posttime, respectively: $F = 1.77$, $p = 0.18$, $\eta^2 = 0.01$ and $F = 0.35$, $p = 0.60$, $\eta^2 = 0.15$. Analysis of the effects of time in each group SIT, BIT, and CON, respectively: $t = 1.15$, $p = 0.26$, $d = 0.19$; **$t = -2.810$, $p = 0.0014$, $d = 0.72$**; $t = -1.96$, $p = 0.07$, $d = 0.22$. (c) $SRT_{distance}$ (m): analysis of group effects in the pretime and posttime, respectively: $F = 0.31$, $p = 0.73$, $\eta^2 = 0.01$ and $F = 1.38$, $p = 0.26$, $\eta^2 = 0.06$. Analysis of the effects of time in each group SIT, BIT, and CON, respectively: **$t = -2.400$, $p = 0.03$, $d = 0.62$**; $t = -0.26$, $p = 0.79$, $d = 0.06$; $t = 1.77$, $p = 0.10$, $d = 0.49$.

Bolded terms in footnote indicate significant differences.

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Table 2

Perceptual and heart rate response during interval trainings.*†

Variable	SIT Session 1	SIT Session 2	SIT Session 3	SIT Session 5	BIT Session 1	BIT Session 2	BIT Session 3	BIT Session 5	Group effect F; p; η^2	Session effect F; p; η^2	Session vs. Group effect F; p; η^2
FS	3.00 ± 1.85 (1.97–4.02)	2.40 ± 1.91 (1.33–3.46)	2.80 ± 1.65 (1.88–3.71)	2.80 ± 1.82 (1.79–3.80)	3.53 ± 1.64 (2.62–4.44)	3.46 ± 1.06 (2.87–4.05)	3.80 ± 1.01 (3.23–4.36)	3.80 ± 1.14 (3.16–4.34)	4.32; 0.04‡; 0.13	0.40; 0.55; 0.02	0.33; 0.79; 0.01
CR-10 RPE	4.8 ± 2.1 (3.6–6.0)	5.2 ± 2.3 (3.8–6.5)	4.9 ± 2.0 (3.8–6.0)	4.1 ± 1.8 (3.0–5.1)	2.8 ± 1.1 (2.1–3.4)	2.7 ± 0.8 (2.3–3.1)	2.4 ± 1.0 (1.8–3.0)	2.3 ± 1.0 (1.7–2.9)§	18.2; <0.001‡; 0.39	2.88; 0.053; 0.09	0.75; 0.52; 0.02
HR_{bas}	66.2 ± 12.7 (59.1–73.2)	64.8 ± 8.7 (59.9–69.6)	64.3 ± 10.4 (58.5–70.1)	60.0 ± 8.2 (56.1–65.2)	61.4 ± 10.4 (55.6–67.2)	58.0 ± 10.3 (52.3–63.8)	58.9 ± 11.0 (52.8–65.0)	60.1 ± 10.9 (54.0–66.2)	1.92; 0.17; 0.06	1.30; 0.27; 0.045	1.12; 0.34; 0.03
HR_{mean}	161.4 ± 15.4 (152.8–169.9)	161.0 ± 12.3 (154.2–167.8)	158.2 ± 12.9 (151.0–165.4)	158.6 ± 12.0 (151.9–165.3)	137.3 ± 18.9 (126.8–147.8)	136.7 ± 20.1 (125.6–147.8)	136.3 ± 20.6 (124.9–147.7)	139.6 ± 20.4 (128.3–150.9)	14.3; 0.001‡; 0.33	0.73; 0.53; 0.02	1.26; 0.29; 0.04
$\%HR_{peak}$	84.0 ± 5.3 (81.0–87.0)	83.9 ± 4.4 (81.4–86.3)	82.4 ± 4.3 (80.0–84.8)	82.6 ± 4.2 (80.3–84.9)	72.4 ± 9.1 (67.3–77.5)	71.9 ± 10.1 (66.3–77.5)	71.8 ± 9.5 (66.5–77.1)	73.5 ± 9.5 (68.3–78.8)	17.5; <0.001‡; 0.38	0.75; 0.49; 0.02	1.29; 0.28; 0.04
Kcals	64.8 ± 14.5 (56.7–72.8)	64.0 ± 13.5 (56.5–71.6)	63.0 ± 13.7 (55.4–70.6)	63.7 ± 13.2 (56.3–71.0)	47.8 ± 16.9 (38.5–57.2)	47.0 ± 16.4 (37.9–56.2)	46.3 ± 17.0 (36.8–55.8)	48.9 ± 16.4 (39.7–58.0)	8.98; 0.006‡; 0.24	1.15; 0.33; 0.04	0.52; 0.66; 0.018
HR_{end}	172.1 ± 15.2 (163.6–180.4)	168.3 ± 11.3 (161.9–174.5)	166.1 ± 13.2 (158.7–173.3)	166.4 ± 12.6 (159.4–173.3)	152.9 ± 16.7 (143.6–162.1)	150.0 ± 18.7 (139.6–160.3)	149.0 ± 18.9 (138.5–159.5)	152.8 ± 18.9 (142.3–163.3)	9.44; 0.005‡; 0.25	3.63; 0.034§; 0.11	1.29; 0.28; 0.04
$HR_{60s\ end}$	125.2 ± 19.5 (114.3–136.0)	121 ± 16.1 (112.0–129.9)	117.9 ± 18.2 (107.7–127.9)	117.5 ± 18.1 (107.5–127.5)	100.8 ± 20.6 (89.3–112.2)	96.4 ± 20.9 (84.8–107.9)	94.2 ± 23.1 (81.4–107.0)	96.4 ± 26.7 (81.6–111.2)	11.1; 0.002‡; 0.28	3.65; 0.016§; 0.11	0.25; 0.85; 0.009
$HR_{120s\ end}$	105.6 ± 16.9 (96.1–115.0)	100.9 ± 12.5 (93.9–107.9)	98.0 ± 17.6 (88.3–107.8)	98.1 ± 16.5 (88.9–107.3)	87.2 ± 18.3 (77.0–97.3)	82.4 ± 18.0 (72.8–92.4)	80.6 ± 19.6 (69.9–91.7)	83.4 ± 21.8 (71.3–95.9)	7.79; 0.009‡; 0.21	5.77 0.001§; 0.170	0.50; 0.67; 0.018
$RMSSD_{bas}$	41.6 ± 20.1 (30.5–52.8)	40.8 ± 23.1 (28.0–53.6)	42.4 ± 16.4 (33.3–51.6)	53.3 ± 25.5 (39.2–67.4)	64.6 ± 32.6 (46.6–82.7)	68.3 ± 31.4 (50.9–85.7)	67.8 ± 26.5 (53.2–82.3)	72.6 ± 35.4§ (52.9–92.2)	7.61; 0.01‡; 0.21	2.49; 0.06; 0.08	0.39; 0.75; 0.01
$RMSSD_{end}$	10.4 ± 7.2 (6.4–14.4)	11.7 ± 9.1 (6.7–16.8)	12.0 ± 10.5 (6.2–17.9)	14.4 ± 14.5 (6.4–22.5)	25.2 ± 19.2 (14.5–35.9)	33.6 ± 25.5 (19.5–47.7)	35.8 ± 25.6 (21.7–50.0)	32.1 ± 25.3 (18.0–46.3)	9.72; 0.004‡; 0.25	3.26; 0.025§; 0.10	1.75; 0.16; 0.05
$R\text{-}R_{bas}$	932.7 ± 173.3 (836.7–1,028.7)	944.1 ± 147.8 (862.2–1,026.0)	946.1 ± 134.7 (871.5–1,020.6)	1,000.6 ± 125.7 (931.0–1,070.2)	994.4 ± 187.1 (890.8–1,098.0)	1,050.2 ± 202.6 (937.9–1,162.3)	1,037.2 ± 174.0 (940.8–1,133.6)	1,022.7 ± 185.7 (919.9–1,125.5)	1.76; 0.19; 0.05	1.25; 0.29; 0.04	1.05; 0.37; 0.03
$R\text{-}R_{end}$	426.8 ± 70.1 (388.0–465.6)	436.9 ± 56.9 (405.4–468.5)	449.9 ± 67.4 (412.6–487.3)	462.1 ± 65.6 (425.8–498.5)	555.7 ± 148.6 (473.4–638.0)	606.0 ± 175.9 (508.6–703.5)	626.5 ± 174.4 (529.9–723.2)	615.3 ± 207.0 (500.6–729.9)	11.56; 0.002‡; 0.29	5.70; 0.001§; 0.16	1.28; 0.28; 0.04

*SIT = sprint interval training; BIT = burpees interval training; FS = feeling scale; CR-10 RPE = rating of perceived exertion category ratio 10 scale; HR_{bas} = heart rate baseline; HR_{mean} = heart rate mean; $\%HR_{peak}$ = percentage of heart rate peak; HR_{end} = heart rate end; $HR_{end\text{-}60s\ end}$ = heart rate after 60 seconds of end; $HR_{end\ 120s\ end}$ = heart rate after 120 seconds of end; $RMSSD_{bas}$ = root mean square of successive differences between R-R intervals baseline; $RMSSD_{end}$ = root mean square of successive differences between R-R intervals end; $R\text{-}R_{bas}$ = R-R intervals baseline; $R\text{-}R_{end}$ = R-R intervals end.

†Data are expressed as mean ± *SD* and limits of the mean confidence interval (95%).

‡Significant group effect.

§Significant session effect.

Table 3

Changes scores of heart rate during interval trainings.*†

Variable	SIT Session 1	SIT Session 2	SIT Session 3	SIT Session 4	BIT Session 1	BIT Session 2	BIT Session 3	BIT Session 4	Group effect F; p; η^2	Session effect F; p; η^2	Session vs. Group effect F; p; η^2
$\Delta HR_{end\text{-}60s\ end}$	46.8 ± 15.4 (38.3–55.4)	47.2 ± 11.2 (41.0–53.4)	48.2 ± 11.9 (41.5–54.8)	48.8 ± 12.2 (42.0–55.5)	52.1 ± 12.1 (45.4–58.8)	53.6 ± 12.8 (46.4–60.7)	54.8 ± 15.3 (46.2–63.3)	56.4 ± 14.4 (48.4–64.3)	2.23; 0.14; 0.074	1.07; 0.36; 0.03	0.12; 0.94; 0.005
$\Delta HR_{end\text{-}120s\ end}$	66.4 ± 15.2 (58.0–74.9)	67.3 ± 7.5 (63.1–71.4)	68.0 ± 11.6 (61.5–74.4)	68.2 ± 11.8 (61.7–74.8)	65.7 ± 11.3 (59.4–72.0)	67.6 ± 10.9 (61.5–73.2)	68.2 ± 13.4 (60.7–75.6)	69.4 ± 11.5 (63.0–75.8)	1.02; 0.38; 0.035	0.003; 0.95; <0.001	0.11; 0.95; 0.004
$\Delta HR_{bas\text{-}end}$	105.8 ± 15.3 (97.3–114.3)	103.4 ± 7.9 (99.0–107.8)	101.7 ± 10.0 (96.1–107.2)	105.7 ± 12.5 (98.7–112.6)	91.4 ± 13.2 (84.1–98.7)	91.9 ± 13.9 (84.2–99.6)	90.1 ± 14.0 (82.3–97.8)	92.7 ± 13.4 (85.2–100.7)	9.62; 0.004‡; 0.25	1.21; 0.30; 0.042	0.26; 0.84; 0.010
$\Delta HR_{bas\text{-}60s\ end}$	59.0 ± 16.0 (50.1–67.8)	56.2 ± 10.1 (50.7–61.8)	53.5 ± 16.1 (44.5–62.5)	56.8 ± 15.7 (48.1–65.5)	39.3 ± 15.3 (30.0–47.8)	38.3 ± 13.7 (30.7–45.9)	35.3 ± 15.1 (27.0–43.7)	36.3 ± 19.0 (25.7–46.8)	15.3; 0.001‡; 0.35	1.48; 0.22; 0.050	0.15; 0.92; 0.005
$\Delta HR_{bas\text{-}120s\ end}$	39.4 ± 16.0 (30.5–48.2)	36.1 ± 10.2 (30.4–41.7)	33.7 ± 14.8 (25.5–41.9)	37.4 ± 14.8 (29.2–45.7)	25.7 ± 12.0 (19.0–32.4)	24.3 ± 10.4 (18.5–30.1)	21.9 ± 11.1 (15.7–28.1)	23.3 ± 13.2 (15.9–30.6)	9.51; 0.005‡; 0.25	2.11; 0.10; 0.07	0.21; 0.88; 0.008
$\Delta RMSSD_{bas\text{-}end}$	31.2 ± 21.3 (19.3–43.0)	29.0 ± 24.8 (15.2–42.8)	30.3 ± 19.3 (19.6–41.0)	38.9 ± 20.5 (27.5–50.2)	39.4 ± 30.4 (22.5–56.2)	34.6 ± 26.3 (20.0–49.2)	31.9 ± 23.8 (18.7–45.1)	40.5 ± 27.4 (25.2–55.7)	0.29; 0.59; 0.01	2.35; 0.07; 0.07	0.41; 0.74; 0.01
$\Delta R\text{-}R_{bas\text{-}end}$	505.8 ± 132.5 (432.4–579.2)	507.1 ± 113.9 (444.0–570.2)	496.1 ± 113.0 (433.5–558.7)	538.5 ± 110.7 (477.1–599.7)	438.7 ± 129.2 (367.1–510.2)	444.1 ± 114.2 (380.8–507.3)	410.6 ± 135.3 (335.6–485.5)	407.4 ± 104.6 (349.5–465.3)	7.12; 0.012‡; 0.20	0.36; 0.77; 0.013	0.84; 0.47; 0.029

*SIT = sprint interval training; BIT = burpees interval training; $\Delta HR_{end\text{-}60s\ end}$ = delta heart rate after 60 seconds of end; $\Delta HR_{end\text{-}120s\ end}$ = delta heart rate after 120 seconds of end; $\Delta HR_{bas\text{-}60s\ end}$ = delta heart rate after 60 seconds of end from baseline; $\Delta HR_{bas\text{-}120s\ end}$ = delta heart rate after 120 seconds of end from baseline; $\Delta RMSSD_{bas\text{-}end}$ = delta root mean square of successive differences between R-R intervals of end from baseline; $R\text{-}R_{bas\text{-}end}$ = R-R intervals of end from baseline.

†Data are expressed as mean ± *SD* and limits of the mean confidence interval (95%).

‡Significant group effect.

increased citrate synthase, cytochrome *c* oxidase subunit IV, and succinate dehydrogenase after 2 weeks of SIT (40). It is possible that some of these adaptations may explain gains in running performance in response to SIT, although further work is needed to confirm this result. Nevertheless, no significant increase in $\dot{V}O_{2max}$ was detected, possibly because of the very low dose of exercise per session (i.e., 40 seconds) and the total sessions performed (i.e., 5 sessions) compared with other studies showing significant increases in $\dot{V}O_{2max}$ with SIT (2,5,6,18,37,40). Despite these no significant findings, it is important to highlight that a gain of 1 $ml\cdot kg^{-1}\cdot min^{-1}$ in $\dot{V}O_{2max}$ was associated with a 9% relative risk reduction of all-cause mortality (23). Thus, our data could have substantial implications for the prevention of several diseases throughout adult life.

The importance of HR in detecting elevated risk of all-cause mortality has been identified (22). In fact, resting and exercise HR, HRR, and HRV are commonly used noninvasive field tools to evaluate adaptations in the regulation of the autonomic nervous system. After prolonged training, HRV and HRR fluctuate in accordance to training load and functional or nonfunctional overreaching (7). For example, moderate training loads generally promote an increase of vagal related HRV indices, whereas high training loads induce a decrease of vagal related HRV indices and slower HRR (7). Positive adaptations decrease the intrinsic rhythmicity of the heart through significant reductions in central sympathetic outflow as a consequence of enhancement in baroflex control and chemoreflex sensitivity (31). Moreover, there are enhancements in peripheral blood flow with increase in nitric oxide synthesis and reduction in cytokines (31). However, we did not detect any change in indicators of autonomic status after 5 sessions of BIT or SIT (Tables 2 and 3). Regarding HRV, there are divergent results concerning the efficacy of low-volume interval training (≥15 min $session^{-1}$). For example, 1 study using HIFT showed improvements in RMSSD and SDNN (42), whereas, another study using SIT did not (5). These equivocal data may be because of differences in training dose, as Songsorn et al. (42) implemented a longer dose of training vs. that of Benítez-Flores et al. (5) (6 vs. 2 weeks). Also, Songsorn et al. (42) recruited insufficiently active adults, whereas Benítez-Flores et al. (5) recruited moderately active adults. Our results also showed no effect of training on HRR. By contrast, Matsuo et al. (27) demonstrated enhanced HRR after 8 weeks of high-volume HIIT (3 × 3 minutes at 85% $\dot{V}O_{2max}$) in sedentary adults. The discrepant results may be explained by the different duration of recording, body position, training duration, type of exercise and training background.

Our results showed that BIT consisting of approximately 30 burpees per day significantly improved jump height. This is the first study exhibiting a moderate enhancement in muscle performance (d = 0.72, +4%; Table 1) in response to completing only burpees as part of HIFT. Nevertheless, there were no changes in absolute or relative peak power development during the jumps. Previously, Schaun et al. (37) reported an improvement in CMJ power output (+4%) and height (+6%) after 16 weeks of HIFT (8 minutes, 8 "all-out" × 20-second efforts) including 4 different exercises (burpees, mountain climbers, squat and thrusts with 3-kg dumbbells, and jumping jacks) in recreationally active adults. Evidence from a meta-analysis shows a significant effect of HIFT on 1 repetition maximum, longitudinal and vertical jump, and strength endurance (39). Therefore, HIFT may be a promising strategy for improving strength in active, non highly trained adults.

No exercise protocol is suitable for wide implementation unless it is well-tolerated by clientele. Our results showed no main effect or interaction for intention 3× a week or 5× a week for BIT or SIT. Previously, a greater intention to participate 5× a week was noted for BIT vs. SIT (28), which does not support our data. Moreover, we observed a significant trend toward lower self-efficacy across sessions for both groups. The self-efficacy score was progressively worse for SIT than for BIT as sessions increased, and significant differences were found in 5× a week frequency ($p = 0.040$, $d = 0.79$). Yet, the response was considerably positive for both protocols in self-efficacy and intention up to 3× a week frequency (i.e., ≥73/100 self-efficacy, ≥5/7 intention). These findings may be associated with minimal changes in CR-10 RPE (≤5, hard) and FS (≥3, good) during training, although a worse response was detected for SIT vs. BIT.

This study has a few limitations. First, data can only be applied to young, active, nonobese adults. Second, we implemented a very low dose of SIT and HIFT, and different findings may occur from regimens characterized by a higher training volume. Third, neither muscular strength nor $\dot{V}O_{2max}$ was measured directly in this study, and further work is needed to determine if these laboratory-based measures can be improved in response to low-volume BIT and SIT. Fourth, although HR is an ecological tool for assessing internal load, it is very sensitive to environmental changes.

Practical Applications

This study was designed to examine the implementation of extremely low-volume interval training in real-world circumstances. Our data in active adults show that 5 sessions of very low-volume running-based SIT enhances run distance, whereas BIT improves vertical jump height. Yet, no improvements were noted in body composition, blood pressure, $\dot{V}O_{2max}$, or autonomic modulation. These results exhibit fitness-related benefits with very low dose of exercise equivalent to 40 s d^{-1} with good adherence, tolerance, self-efficacy, and intention to engage 3× a week frequency. Thus, strength and conditioning professionals and enthusiasts should consider planning sessions with approximately 10 very short yet intense bouts to potentially mitigate sedentary behavior. However, strength and conditioning professionals have to apply running-based SIT with caution because it can cause musculoskeletal injury, and we suggest a preparatory training plan before starting "all-out" running SIT (e.g., submaximal sprint bouts) or completing other modalities (e.g., cycling or rowing). Another option is to design programs with HIFT because it is a modality with promising results in health indicators that has been established as one of the main trends in the fitness industry. Future studies should replicate these protocols in untrained, sedentary, or at-risk populations.

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We thank the participants for their dedication to the study. No potential conflict of interest was reported by the authors. The results of the present study do not constitute endorsement of the product by the authors or the NSCA. Data availability: All data obtained in this study are available within the article. Author contributions: P. Pérez-Ifrán: conceived and designed the investigation, analyzed and interpreted the data, drafted the paper, and approved the final version submitted for publication. C. A. Magallanes: conceived and designed the investigation, analyzed and interpreted the data, drafted the paper, and approved the final version submitted for publication. F. A. de S. Castro: analyzed and interpreted the data, drafted the paper, and approved the final version submitted for publication. T. A. Astorino: analyzed and interpreted the data, drafted the paper, and approved the final version submitted for publication. S. Benítez-Flores: conceived and designed the investigation, analyzed and interpreted the data, drafted the paper, and approved the final version submitted for publication. Institutional Ethics Committee Statement: The Ethics Committee from the Higher Institute of Physical Education, University of the Republic approved this study in accordance with the Declaration of Helsinki (November 4, 2020). Funding: This work was supported by the [CSIC, University of the Republic, Uruguay] under Grant [192, 2018].

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Montevideo, 30 de enero de 2024

Srs. Miembros de la Comisión Central de Dedicación
Total de la Universidad de la República

De mi mayor consideración.

Por medio de esta carta avalo académicamente el Plan de Actividades presentado por el Dr. Stefano Benítez-Flores para postular al régimen de Dedicación Total.

El Proyecto de Investigación *“Efectos sobre el síndrome metabólico del entrenamiento interválico de esprints muy breves combinado con entrenamiento de fuerza con una baja o alta perdida de velocidad dentro de modelos de entrenamiento concurrente”* propuesto por el Dr. Benítez-Flores posee particular relevancia en el campo del ejercicio físico vinculado a la salud y posibilitará generar diversos insumos aplicables a actividades de enseñanza a nivel de grado y posgrado, así como también a actividades de extensión.

En lo que a mi corresponde, asumo el compromiso de supervisar y guiar al docente en la realización de su proyecto de investigación de acuerdo a los parámetros de excelencia académica, honestidad y respeto mutuo.

Atentamente,

Prof. Agdo. Carlos Magallanes
Dir. Departamento de Educación Física y Salud, ISEF, UDELAR

Proyecto: Efectos sobre el síndrome metabólico del entrenamiento interválico de esprints muy breves combinado con entrenamiento de fuerza con una baja o alta perdida de velocidad dentro de modelos de entrenamiento concurrente

Resumen

El entrenamiento concurrente (EC) que suma entrenamiento de resistencia (ER) y fuerza (EF) en un mismo régimen, es una modalidad altamente practicada en la actualidad; ya que tiene la esencial virtud de mejorar la función cardiorrespiratoria y neuromuscular análogamente. A pesar de que fue relatado en numerosos estudios un fenómeno de interferencia que provocaría el ER en el desempeño musculo-esquelético, actuales evidencias enfatizan que con modelos de ER de alta intensidad y bajo volumen dichas respuestas no son vislumbradas. Por otro lado, todavía no fue esclarecido el impacto que tendría el EC en la salud cardiometabólica. En este sentido, es necesario continuar con la exploración de enfoques de actividad física (AF) fáciles de implementar dado su efecto multisistémico, que puedan mitigar el aumento exponencial del sedentarismo y sus efectos negativos en la salud. Por lo tanto, este diseño de investigación a desarrollarse en el Hospital de Clínicas, se propone indagar como pequeñas dosis de EC, pueden ayudar a mejorar factores ligados al síndrome metabólico (SMET) en funcionarios de la Udelar. El proyecto adoptará un diseño controlado aleatorizado con un enfoque de doble ciego, durante 8 semanas de intervención, midiendo cambios en variables fisiológicas, físicas y clínicas. Este proyecto impulsaría el I+D a nivel nacional en un área de muchísimo valor, dado que mejoraría radicalmente la calidad de vida, la productividad y el ausentismo laboral de los implicados. De hecho, se pretende generar para dicho proyecto un espacio de formación integral (EFI), donde exista un fuerte vínculo con la comunidad, desde una perspectiva interdisciplinar y holística. Adicionalmente, se busca aportar al desarrollo de académicos/profesionales sumando al I+D alumnos de distintos niveles de formación, con el objetivo principal de instaurar y masificar prácticas basadas en evidencias científicas, cuestión que el sector carece. Para este cometido se proyecta continuar la enseñanza e investigación en los tres niveles (grado, posgrado, formación permanente), dotando las aulas de experiencias prácticas que le sirvan a los estudiantes como herramientas robustas para el campo profesional. Para esta actividad se cuenta con el apoyo del Dr. Carlos Magallanes, Dr. Eduardo Cadore y Dr. Todd Astorino. A través de este vínculo, se pretende fortalecer la relación interinstitucional fomentando el intercambio entre académicos y desenvolviendo procesos de I+D conjuntamente. En este sentido, se planifica realizar una estancia posdoctoral en la CSUSM junto al Dr. Todd Astorino.

Investigación

Antecedentes

El entrenamiento concurrente (EC) es definido como la conjunción de entrenamiento de resistencia (ER) y entrenamiento de fuerza (EF) en un mismo régimen (1). Combinar estos modelos de ejercicio puede ser una opción eficiente, dado que a la misma vez se estimula el sistema cardiorrespiratorio y neuromuscular. Diversos estudios epidemiológicos con grandes muestras, han confirmado que tanto el VO_2max como la fuerza, están inversamente asociados a cualquier causa de mortalidad (2,3). Además, actualmente fue constatado que el riesgo de muerte por enfermedad cardiovascular o cáncer, es más bajo en sujetos que tienen simultáneamente un mayor fitness cardiorrespiratorio y fuerza de prensión manual (4). A pesar de estos datos, fue sugerido hace algunas décadas que el ER y EF ejecutados de forma concomitante, puede generar una competencia en las adaptaciones fisiológicas (1). Así, mediante un trabajo clásico, Wilson et al. (1) resumieron que el alto volumen o intensidad inducido por el ER desenvolvería significativamente un "efecto interferencia", atenuando las respuestas agudas/crónicas músculo-esqueléticas. Estos efectos fueron replicados más recientemente usando solo entrenamiento interválico (5), una modalidad con notables efectos cardiometabólicos iguales o superiores que protocolos convencionales de ER [es decir, entrenamiento continuo de moderada intensidad (MICT)] (6,7). No obstante, los potenciales beneficios clínicos del EC no están claros. Por ejemplo, un meta-análisis referente, no encontró que esta modalidad fuera superior en optimizar factores del síndrome metabólico (SMET), que instruir de manera aislada ER (8). Álvarez et al. (9) demostraron en mujeres con resistencia a la insulina, que luego de 12 semanas el EF era el enfoque que lograba un menor número de no respondedores en 20 parámetros cardiometabólicos. Datos publicados por nuestro equipo en el 2019, señalaron que la integración de entrenamiento interválico de esprints (SIT) con esfuerzos muy breves (es decir, 5 s) a un bloque de fuerza explosiva, con un bajo volumen por sesión (~12 min), no causaba "efecto interferencia" permitiendo la optimización de la fuerza y de otras variables de riesgo cardiometabólico (estrés oxidativo, VO_2max, etc.), luego de 2 semanas de EC (10). Más recientemente, Andrade et al. (11) reclutaron a sujetos con SMET, dividiendo a los participantes en subgrupos por edad, observando una mejora en el perímetro de cintura y la aptitud cardiorrespiratoria en todos los subgrupos; mientras que la glucosa en plasma y la presión arterial solo mejoraba en algunos subgrupos, luego de 10 semanas de EC aplicando entrenamiento interválico. Aunque, en este diseño no se evaluó la fuerza y la duración de cada sesión alcanzaba los 60 min. En este sentido, la falta de tiempo es una barrera altamente mencionada para no practicar actividad física (AF) (12). Actualmente en Uruguay, un 25% de la población no alcanza las recomendaciones de AF, hallándose notoriamente una peor respuesta en las porciones de mayor edad, mayor pobreza o bajo nivel educacional (13); generando este fenómeno una aceleración en el desarrollo de las enfermedades cardiometabólicas. De este modo, las recomendaciones clásicas de AF no han tenido el deseado impacto, debido a que los índices de sedentarismo y obesidad junto al gasto sanitario crecen cada año (14). En las actuales recomendaciones ya se plantea que no es necesario acumular bloques de 10 min para que la AF tenga un impacto en la salud, dado que cualquier duración ya reduce la mortalidad por cualquier causa (15). Además, un reciente meta-análisis, comprobó que sesiones muy cortas (es decir, ≤15 min) de entrenamiento interválico, ya mejoran significativamente el SMET, no existiendo diferencias frente a sesiones más largas de entrenamiento interválico o MICT (16). Adicionalmente, otro meta-análisis confirmó que sesiones que aplican esfuerzos muy breves (es decir, ≤10 s), incrementan significativamente el VO_2max (17). Por lo tanto, es necesario avanzar en diseños que puedan aplicarse en mundo real, con un bajo tiempo de compromiso diario/semanal y ejecutados en ambientes de fácil implementación (por ejemplo, contexto laboral) en poblaciones patológicas (18). Teniendo en cuenta los presentes antecedentes y de acuerdo a mi conocimiento, el objetivo del siguiente proyecto es indagar el efecto crónico de diferentes regímenes con bajo volumen de EC (incorporando SIT corto y EF con una baja o alta perdida de velocidad) en comparación con EF o SIT de forma aislada, integrando sujetos con SMET. Nuestra hipótesis es que el grupo que implemente EC, tendrá una superior modificación de parámetros de la función neuromuscular y salud cardiometabólica.

Metodología

Diseño: Este estudio será formalizado en el Centro Cardiovascular del Hospital de Clínicas, con tecnología y equipamiento otorgados por CSIC y el Hospital. Se adoptará un diseño controlado aleatorizado a doble ciego. Los participantes realizarán 16 sesiones, con tres días de valoraciones (pre- y post- tratamientos). Cada entrenamiento tendrá ~15 min de duración con 48-72 h de recuperación. Todas las sesiones serán a la misma hora del día con condiciones ambientales constantes. El primer día se realizará la familiarización con las evaluaciones y los modelos de ejercicio físico. A lo largo del segundo y tercer día se ejecutarán las pruebas físicas y clínicas, replicándose post-entrenamiento. A partir del cuarto día se comenzarán a aplicar las intervenciones, controlándose la AF incidental, el sueño y la ingesta alimenticia, ya que son factores que pueden confundir las respuestas biológicas.

Participantes: Setenta y dos funcionarios de la Udelar serán invitados a ser parte de esta investigación contemplando determinados criterios de inclusión: 1) cumplir tres de los cinco indicadores clínicos identificados para SMET (8); 2) no consumir ningún tipo de suplemento nutricional o tabaco; 3) estar libre de cualquier lesión o problemática cardiovascular. Los participantes se asignarán al azar en seis grupos; grupo SIT (SIT; n=12); grupo EF con baja perdida de velocidad (EFBPV; n=12); grupo EF con alta perdida de velocidad (EFAPV; n=12); grupo EC integrando SIT y EF con baja perdida de velocidad (ECBPV; n=12); grupo EC integrando SIT y EF con alta perdida de velocidad (ECAPV; n=12) y grupo control (CON; n=12). El CON no realizará entrenamientos. Todos los grupos, recibirán instrucciones de mantener su estilo de vida habitual evitando cualquier AF estructurada. Antes del comienzo, los procedimientos y los riesgos potenciales se explicarán de forma escrita y verbal siguiendo los principios de la Declaración de Helsinki.

Composición corporal: La masa y la grasa corporal se registrarán con 2 métodos diferentes, una bioimpedancia (OMRON HBF-514, Kioto, Japón) y un DEXA (Hologic, Watham, MA, EEUU). La altura se medirá con un estadiómetro (Seca, Hamburgo, Alemania). Complementariamente, se cuantificará el perímetro de cintura y cadera con una cinta antropométrica (SN 4010; Sanny Medical Starret, São Paulo, Brasil).

Test de resistencia incremental: Se utilizará un cicloergómetro (Technogym Cycle, Italia), efectuando un protocolo que consistirá en aumentos progresivos de 1 W cada 2 s hasta el agotamiento o cuando la cadencia caiga por debajo de 50 rpm. El VO_2, el CO_2 y el volumen espiratorio se medirán cada 20 s empleando un analizador de gases (Cortex, Metalyzer, Leipzig, Alemania). El VO_2max se definirá como el valor más alto de VO_2 registrado durante 20 s con criterios previamente establecidos (10). Igualmente se determinará la potencia máxima (P_{max}) (10).

Test de fuerza isoinercial: Este test consistirá en realizar Sentadilla en “Multipower” (Technogym, Italia) con cargas crecientes submáximas. La prueba es una manera sencilla de valorar la función neuromuscular sin riesgo de lesiones (10). Los participantes realizarán 5 series secuencialmente: 1) cinco reps con la carga de la barra libremente; 2) cinco reps con ~30% de la masa corporal libremente; 3) cinco reps con 50% de la masa corporal libremente; 4) cinco reps con 50% de la masa corporal máximalmente; 5) cinco reps con 50% de la masa corporal máximalmente. Máximalmente se refiere a mayor velocidad posible. Habrá 2 min de recuperación entre series. La potencia media y pico, la velocidad media y pico, también la fuerza media y pico se registrarán durante la fase concéntrica para cada reps en la última serie, con un acelerómetro valido y confiable (19) (PUSH Band 2.0, Toronto, Canadá).

Test funcionales: Las pruebas de rendimiento funcional comprenderán 2 evaluaciones “Sit-to-stand” y “Timed-up-and go”, ya usadas previamente (20).

Grosor muscular: El grosor muscular se apreciará de forma no invasiva mediante ultrasonido. Imágenes transversales del cuádriceps derecho (es decir, vasto lateral, vasto intermedio, vasto medial y recto femoral) se tomarán con un dispositivo portátil (Nemio XG, Toshiba, Japón). Antes de la colecta de imágenes, las ubicaciones anatómicas se identificarán y marcarán según recomendaciones previas (21). Todas las imágenes de ultrasonido se digitalizarán y analizarán a través de un software especifico. Íntegramente, las mediciones serán efectuadas por el mismo científico, especialista en dichas valoraciones.

Balance autonómico: La variabilidad de la frecuencia cardíaca (VFC) se examinará con registros ultracortos confiables (22), en posición sedante antes y después del test incremental usando un software (Firstbeat Technologies, Jyväskylä, Finlandia). Se utilizarán parámetros lineales y no lineales de VFC. Al mismo tiempo, se usarán los 2 min post-incremental para analizar el comportamiento de la recuperación de la FC (RFC), tal cual se aplicó en un trabajo reciente de nuestro grupo (23). Adicionalmente, se utilizarán los mismos métodos de registro en la última sesión semanal, para hacer un seguimiento semana a semana de las adaptaciones en la función autonómica.

Homeostasis de la glucosa: Se extraerán muestras de sangre (4 ml) luego de un ayuno de 10 h. La glucosa plasmática se medirá mediante métodos enzimáticos utilizando kits estándar (Wiener Lab Inc, Rosario, Argentina) con un analizador automático (Metrolab 2300 Plus, Buenos Aires, Argentina). La insulina se medirá con un radioinmunoensayo (Diagnostic Products Corp, Los Angeles, EEUU). El índice HOMA-IR se calculará manejando la ecuación de Matthews: [glucosa (mg/dL) × insulina (μIU/mL) /405] (24). Se replicarán las condiciones 72 h luego de la última sesión de entrenamiento.

Presión arterial: La presión arterial sistólica (PAS) y diastólica (PAD) se evaluarán a través de un tensiómetro digital valido y confiable (25) (OMRON 7120, Kioto, Japón) siguiendo recomendaciones previas (26), antes y después del test incremental aplicando 2 mediciones con 1 min de pausa (tomando la media). También, se van a emplear los mismos registros en la última sesión semanal para completar un seguimiento.

Calidad de vida: Se evaluará la percepción de la calidad de vida entre los individuos usando el cuestionario validado PROMIS (27).

Actividad Física incidental y Sueño: La AF incidental y el Sueño se controlarán con acelerómetros (GT3X ActiGraph, FL, EEUU) durante 7 días/24 h en un período aleatorio usando algoritmos ya establecidos (28,29).

Ingesta alimenticia: Pre-post mediciones y durante el período de intervención (7 días de la semana y 3 días del fin de semana aleatorios) se realizará un seguimiento de la ingesta dietética usando técnicas previamente instrumentadas (10).

Modos de Entrenamiento: Los programas de entrenamiento implicarán 2 sesiones por semana durante 8 semanas (es decir, 16 sesiones). El SIT entrenará en un cicloergómetro (Technogym Cycle, Italia) con una carga del 7.5% del peso corporal. Los grupos de EC combinarán SIT con Sentadilla (mitad de la sesión cada ejercicio) con una carga equivalente al 50% de la masa corporal. Esta baja carga mejora la función neuromuscular, sin la necesidad de recurrir a altos pesos con riesgos lesivos (10). Preliminarmente, fue sugerido que los ejercicios seleccionados (es decir, sentadilla y esprint) tienen una similar activación y biomecánica muscular (1), pudiendo lograr una equivalente carga externa. Con el objetivo de comparar si el nivel de estrés generado durante el EF es necesario para promover adaptaciones morfológicas y de desempeño neuromuscular; el EFAPV y el ECAPV entrenará realizando series con reps hasta una pérdida de velocidad del 50%, mientras que el EFBPV y el ECBPV ejecutará series con reps hasta una pérdida del 25% (30), controlando esto con un acelerómetro (PUSH Band 2.0, Toronto, Canadá). Este es un elemento clave, dado que la adaptación en el sistema neuromuscular puede estar ligada a la preservación de fibras tipo IIx que induce la baja pérdida de velocidad inter-repetición (31). Los protocolos de entrenamiento tendrán un tiempo total similar, con igual recuperación inter-series: SIT: 6-12 series de 5 s con 40 s de recuperación; EFAPV: 6-12 series con 40 s de recuperación; EFBPV: 6-12 series con 40 s de recuperación; ECAPV: primera parte SIT y segunda parte EF 3-6 series con 40 s de recuperación; ECBPV: primera parte SIT y segunda parte EF 3-6 series con 40 s de recuperación. Se controlará en cada entrenamiento: Frecuencia cardiaca, trabajo total (kJ), percepción subjetiva del esfuerzo (PSE) y escala afectiva (FS) (22). Adicionalmente se incluirá la escala PACES (32).

Análisis estadístico: El efecto del entrenamiento se evaluará con “ANOVA-two way” (tiempo × grupo). Si es apropiado se conducirán comparaciones (intra e inter-grupo) con la corrección de Bonferroni mediante SPSS (IBM, NY, EEUU). Se cuantificará el tamaño del efecto. El nivel de significancia será $p < 0.05$.

Enseñanza

Participarán como colaboradores estudiantes de 4º año de la LEF del ISEF, que estén cursando la asignatura Seminario de Tesina Salud 2024. Asimismo, participarán 2 alumnos de maestría PEDECIBA. Aspiramos a que estos estudiantes puedan acompañarnos en las etapas experimentales, concibiendo sus primeros pasos en la producción de conocimiento y aportando al desarrollo de académicos en un área clave dentro del sector sanitario. Igualmente, deseamos que parte de los implicados luego de transcurrir dichas fases, se integren al eje biológico como docentes; llevando los saberes producidos a las aulas, con el objetivo de que exista una transferencia de conocimiento y así demostrar la importancia del ejercicio físico basado en evidencia. Adicionalmente, se pretende continuar desarrollando enseñanza a distintos niveles (es decir, grado, posgrado, formación permanente) con un rol de liderazgo como he tenido hasta el momento a pesar de que mi cargo es G2; procurando establecer una fuerte conexión entre la creación de nuevas evidencias y el contenido de los cursos, desde una posición vanguardista. En este sentido, se propone extender el crecimiento interdisciplinar para el tratamiento de problemáticas actuales de salud pública, tejiendo redes y desarrollando I+D entre áreas/facultades de las ciencias de la salud desde el Hospital de Clínicas. Además, este proyecto incluirá nuevamente la participación de referentes mundiales como el Dr. Eduardo Cadore de la UFRGS y el Dr. Todd Astorino de la CSUSM, sosteniendo vínculos con centro reconocidos a nivel regional e internacional. Dichos docentes se integrarán a actividades de formación del ISEF. Por último, se planifica realizar una estancia posdoctoral en la CSUSM junto al Dr. Todd Astorino. Este proyecto será supervisado por el Dr. Carlos Magallanes (G4, ISEF) y Dr. Federico Ferrando (G3, Hospital de Clínicas).

Extensión

Se aspira a crear un espacio de formación integral (EFI) dentro del Hospital de Clínicas, que sea modelo a nivel nacional en rehabilitación cardiometabólica, cuestión claramente necesaria y sin precedentes. En el mismo, se desarrollará de manera conjunta las tres funciones de la Udelar junto a diversas carreras (es decir, educación física, nutrición, medicina, etc.) y la comunidad de funcionarios. El sedentarismo junto a sus problemas asociados de salud, son una nefasta pandemia, siendo el ejercicio físico una polipíldora. La inclusión de funcionarios va a permitir que puedan mejorar la productividad laboral, reducir el ausentismo laboral y potenciar su bienestar físico/psicológico. Con motivos de facilitación, esta propuesta se enmarca en el lugar convencional de trabajo. Igualmente, un propósito implícito de este EFI, es cultivar estilos de vida saludables que puedan repercutir en la morbimortalidad y el gasto sanitario (por ejemplo, fármacos, diagnósticos, cirugías, etc.). De esta manera, se procurará la educación del núcleo familiar, dado que es un elemento clave para reproducir y mantener las rutinas a largo plazo. También, se pretende extender y difundir los resultados desde los programas intrahospitalarios a diversos centros/facultades Udelar, así como también a instituciones y colectivos como los espacios de recreación y deportivos asociados; para que se puedan generar propuestas para estas poblaciones marginalizadas, por su baja condición física y el desconocimiento de que tipo de ejercicio físico es el óptimo para su problemática en particular. Finalmente, se procurará avanzar en una modalidad en auge como es la telerehabilitación, para llegar al interior dónde la Udelar tiene presencia.

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Formulario de Ingreso al Régimen de Dedicación Total

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Título del Plan de Actividades:
Efectos sobre el síndrome metabólico del entrenamiento interválico de esprints muy breves combinado con entrenamiento de fuerza con una baja o alta perdida de velocidad dentro de modelos de entrenamiento concurrente

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Designación (Docente)	Comisión Directiva	74	03/04/20	008150-000183-20	03/04/20	31/03/21			155110100
Prórroga en el Cargo	Comisión Directiva	49	26/02/21	008440-501734-20	01/04/21	31/03/22			155110100
Prórroga en el Cargo	Comisión Directiva	30	25/03/22	008440-503414-21	01/04/22	31/03/23			155110100
Prórroga en el Cargo	Comisión Directiva	7	31/03/23	008440-000610-22	01/04/23	31/03/24			155110100
Extensión Horaria Docente	Comisión Directiva	57	08/05/20	008440-000968-20	01/05/20	31/03/21	20-29		155110100
Extensión Horaria Docente	Comisión Directiva	15	20/10/20	008150-500106-20	01/10/20	25/12/20	29-39		155110200
Extensión Horaria Docente	Comisión Directiva	45	09/04/21	008150-500290-21	01/04/21	31/03/22	20-23		155110100
Licencia Con Goce de Sueldo	C.D.A.	38	13/09/22	008440-000397-22	30/08/22	08/12/22			

Nº CARGO	DENOMINACIÓN	CATEGORÍA	ESC/SUB	CARRERA	CARÁCTER	FORMA DE ACCESO	GRADO	HORAS
556110	Asistente	Docente	G.0.01	Docente	Contratado	Designación directa	2	20

INSTITUCIONAL: 26.001.550.06.04.01 - Centro Montevideo
PARTIDA PRESUPUESTAL: 155110200 - ISEF Centro Montevideo Prog102

MOVIMIENTO	ÓRGANO EMISOR	Nº RESOLUCIÓN	FECHA RESOL.	Nº EXPEDIENTE	FECHA DESDE	FECHA HASTA	HORAS	PORCENT.	PART. PRESUPUESTAL
Designación (Docente)	C.D.C.	8	04/06/19	008050-000097-19	13/06/19	31/12/19			155110200
Prórroga en el Cargo	C.D.A.	56	11/02/20	008440-002990-19	01/01/20	30/09/20			155110200
Extensión Horaria Docente	Comisión Directiva	43	12/07/19	008150-000340-19	01/07/19	22/12/19	20-26		155110200

	Expediente Nro. 008440-000023-24 Actuación 2	Oficina: COMISIÓN DE DEDICACIÓN TOTAL - CENTRO MONTEVIDEO - ISEF Fecha Recibido: 06/02/2024 Estado: Cursado

TEXTO

Montevideo, 27 de Mayo de 2024.-

Se adjunta informe de la Comisión de DT y evaluación correspondiente.

Pase a Sección Personal.

Firmado electrónicamentemente por NOELIA ALMEDA PEREIRA el 27/05/2024 14:42:02.

Nombre Anexo	Tamaño	Fecha
Evaluación_DT_StefanoBenítez_especialista.pdf	57 KB	27/05/2024 09:56:00
Informe solicitud DT Benitez.pdf	221 KB	27/05/2024 09:56:00

Descripción de Anexos
Los documentos adjuntos fueron remitidos por correo institucional.

Evaluación de postulación para Ingreso a Régimen de Dedicación Total para personal Docente (Universidad de la República)

- Postulante: Dr. Stefano Benítez (período inicial: tres años)
- Fecha del informe: 14/05/2024

La presente evaluación se realiza teniendo en consideración los aspectos que el "Estatuto del Personal Docente" (Artículos 74, 79 y 80) establece para un docente que aspire ingresar al Régimen de Dedicación Total. A saber:

- **Artículo 74.** "La Universidad de la República, con el objeto de fomentar el desarrollo integral de la actividad docente, ***estimulando dentro de ésta especialmente la investigación y otras formas de actividad creadora y la formación de nuevos investigadores***, establece un régimen de dedicación total al que podrán aspirar todos sus docentes. *Los docentes en régimen de dedicación total deberán consagrarse integralmente a sus tareas*, con exclusión de toda otra actividad remunerada u honoraria, con las precisiones establecidas en el Artículo 76. (...)"

- **Artículo 79.** "Toda solicitud de concesión del régimen de dedicación total especificará los cargos en que se solicita y vendrá acompañada de:
  Una ***relación detallada de méritos y antecedentes***, en especial en lo atinente al campo de estudio al que se propone dedicarse exclusivamente el solicitante. Adjuntará la documentación que estime conveniente.
  Un ***esquema del plan de actividades que proyecta desarrollar de inmediato, al efecto de acreditar el propósito de realizar un trabajo serio e intenso***.
  El docente podrá, en el curso de su trabajo, introducir las modificaciones que estime razonables en vista del desarrollo del mismo. En este esquema el solicitante deberá establecer en forma explícita las necesidades mínimas en personal y equipos de su plan, así como una estimación de las erogaciones suplementarias que insumirían. En el caso de un docente que, por la naturaleza de sus funciones, desarrolle una parte importante de sus actividades bajo la dirección de otro o de otros, podrá complementarse este esquema mediante un informe del jefe del servicio en que trabaja el solicitante, resumiendo el plan de actividades en que éste habrá de participar.

- **Artículo 80.** "Para la concesión del régimen ***se atenderá a las aptitudes, vocación y preparación del solicitante para lo cual se tendrá en cuenta principalmente la experiencia y dedicación en la disciplina y la capacidad demostrada para la investigación o actividad creadora en la misma apreciadas con referencia al nivel de responsabilidad que implique la jerarquía funcional del solicitante; condiciones que, junto con su solvencia moral, deberán justificar en lo intelectual, técnico y ético la presunción de que se cumplirán los fines del régimen***".

Del análisis de la documentación brindada, surgen los siguientes comentarios.

[1]. Méritos y antecedentes: artículos científicos y CVUy.

El postulante adjunta tres artículos científicos. El primero de ellos, publicado en 2018, es un trabajo original realizado durante su estancia en Brasil, en donde la primer autoría refleja probablemente su participación protagónica en el mismo. En el trabajo se presenta un abordaje experimental que presenta similitudes (ej. temática, diseño experimental, algunas variables biológicas a medir) con el propuesto como parte del plan de trabajo para solicitar su ingreso al Régimen de Dedicación Total. El segundo, en el que se ubica como co-autor, es una revisión sistemática y metanálisis sobre los efectos de un tipo de entrenamiento sobre índices de rendimiento cardio-respiratorio. Fue realizado enteramente con autores del exterior. El tercero, realizado a partir de investigación original realizada en Uruguay, y del que participan otros integrantes del Instituto Superior de Educación Física (ISEF), es un trabajo dedicado a evaluar comparativamente el impacto de diferentes tipos de entrenamiento sobre algunos sub-determinantes de la condición física y algunas variables de función cardiovascular.

En conjunto, el análisis de estas publicaciones y de la información brindada en su CVUy, dan cuenta de un profesional formado en Educación Física, de 40 años de edad, con Doctorado en Educación Física (Brasil), que cuenta con experiencia en participar de estudios de investigación original en el área temática en que presenta su plan de trabajo. Es un investigador que se encuentra en etapa de consolidación. Integra el Sistema Nacional de Investigadores (SNI-ANII, Nivel ´Iniciación´), el Programa de Desarrollo de las Ciencias Básicas (PEDECIBA), y si bien no cuenta aún con procesos culminados de formación de recursos humanos en investigación científica [Maestrías o Doctorados], cuenta con dos estudiantes activos recientemente inscriptos en la Maestría PEDECIBA (Área Biología; Sub-Área: Ciencias Fisiológicas). Adicionalmente a estas fortalezas, se destaca que ya ha desarrollado, y plantea realizar, un trabajo interdisciplinario, que necesariamente requiere la generación de redes inter-personales e inter-institucionales que sin duda enriquecen la actividad propuesta. Se suma a las fortalezas, ser un profesional que cuenta con colegas de otros países e instituciones, con los que ya estableció (y plantea seguir estableciendo) diversas colaboraciones científico-académicas.

Presenta como principal limitación ser un profesional que no presenta un Laboratorio y/o Grupo específico del ISEF de referencia, en donde se encuentre trabajando, y/o que sea referencia de su trabajo. Esto genera que sea complejo evaluar las capacidades con las que cuenta para desarrollar investigación científica en el ISEF. A modo de ejemplo, dada la forma en que describe su Plan de Trabajo, y por omitir esto en su CVUy, se desconoce si cuenta con equipo humano, con equipamiento tecnológico y/o con instalaciones que le permitan desarrollar su propuesta.

[2]. Plan de actividades

Consideraciones generales

El documento denominado "Plan de Actividades" presenta un título que hace referencia a un proyecto de investigación específico. Si bien se espera que un docente en Régimen de DT se dedique intensamente a la investigación científica, sería recomendable que el título de un Plan de Trabajo, que debería incluir la totalidad de las funciones universitarias docentes esenciales, sea algo más abarcativo y genérico. En general, este aspecto es una limitación importante de la propuesta, ya que lo que se presenta son algunas ideas (no muy detalladas) de un proyecto de investigación, más que un plan integral de actividades. En otras palabras, lo presentado adolece de ser un Plan de Trabajo, a la vez que tampoco termina siendo un proyecto de Investigación. En este sentido, sugiero valorar que el mismo sea reformulado. Entre lo fundamental de un Plan de Trabajo, que de ser ejecutado deberá ser evaluado, es que existan indicadores mensurables de actividad, que permitan en el futuro evaluar el cumplimiento. A estos efectos, incluir cronogramas, actividades específicas, hitos, etc. es recomendable.

Consideraciones específicas

Resumen

- **Resumen.** Se afirma: *"Este proyecto impulsaría el I+D a nivel nacional en un área de muchísimo valor, dado que* <u>*mejoraría radicalmente la calidad de vida, la productividad y el ausentismo laboral*</u> *de los implicados"*. En opinión de este evaluador, es extremadamente aventurado y no es factible afirmar que un proyecto con este diseño tendrá esa magnitud de impacto.

- **Resumen.** Se afirma: *"Adicionalmente, se busca aportar al desarrollo de académicos/profesionales sumando al I+D alumnos de distintos niveles deformación,* <u>*con el objetivo principal de instaurar y masificar prácticas basadas en evidencias científicas, cuestión que el sector carece*</u>*"*. En opinión de este evaluador, debería aclararse a lo que se hace referencia al afirmar que "el sector" carece de prácticas basadas en evidencia científica. Puede llegar a resultar ofensivo. ¿Se aplican tratamientos y/o protocolos de rehabilitación cardiovascular que carecen de respaldo en evidencia científica?

- **Resumen.** Se afirma: *"Para este cometido se proyecta continuar la enseñanza e investigación en los tres niveles (grado, posgrado, formación permanente), dotando las aulas de experiencias prácticas que le sirvan a los estudiantes como herramientas robustas para el campo profesional".* Sin embargo, posteriormente en el apartado de Enseñanza no se detalla ningún curso específico (o tarea concreta) de grado, posgrado, etc. que se vaya a proponer y/o a profundizar, y en el curso que se realizaría. En opinión de este evaluador, lo que se proyecta realizar en un Plan de Trabajo, debe ser explicitado con acciones lo más concretas posibles, que posteriormente puedan evaluarse.

Investigación

Antecedentes. En el apartado Antecedentes se describe de manera escueta, pero suficientemente, el problema y los objetivos del proyecto. Los mimos serían: *"... indagar el efecto crónico de diferentes regímenes con bajo volumen de EC (incorporando SIT corto y EF con una baja o alta pérdida de velocidad) en comparación con EF o SIT de forma aislada, integrando sujetos con SMET"*. A su vez, si bien no queda claro el fundamento por el que plantean dicha hipótesis, la misma es clara *"Nuestra hipótesis es que el grupo que implemente EC, tendrá una superior modificación de parámetros de la función neuromuscular y salud cardiometabólica".*

Metodología. Se detalla que el proyecto de investigación será realizado en el Centro Cardiovascular del Hospital de Clínicas, empleando tecnología y equipamiento otorgados por CSIC y el Hospital de Clínicas. En opinión de este evaluador, sería importante tener claro si ya se cuenta con ese equipamiento por parte del postulante y/o del ISEF, o si por el contrario es equipamiento que se desea adquirir a futuro, ya que de eso depende la factibilidad del proyecto planteado. Si se plantea adquirir a futuro, entonces debería ser parte del Plan de Trabajo un apartado que dé cuenta de las medidas a tomar para la consecución del equipamiento.

De la lectura del proyecto, surgen numerosas inquietudes, principalmente por omisión de información, que generan dudas sobre la rigurosidad y calidad del proyecto diseñado. Se brindan algunos ejemplos:

- Se hace mención a que se controlará la actividad física incidental, el sueño y la ingesta alimenticia. Entiendo que se medirán aspectos relacionados con estas variables. Pero: ¿Cómo se controlarán estas variables? ¿A qué hacen referencia con ´controlar´? Si es un control estadístico, debería aclararse en el correspondiente apartado; y la manera de hacerlo con este tamaño muestral. ¿Cómo se controlará el efecto de la medicación farmacológica y/u otros tratamientos que consumen/reciban las personas?
- Deben especificarse cuáles son los cinco indicadores clínicos identificados para SMET. ¿Pude este proyecto concluir sobre la "mejoría crónica" del SMET?
- ¿A qué hacen referencia con el criterio de inclusión denominado "estar libre de cualquier lesión o problemática cardiovascular"? ¿Se excluyen hipertensos?
- ¿Dónde serán realizadas las mediciones con analizadores de gases y con DEXA? Debe aclararse en un plan de trabajo, las instalaciones y/o servicios que serán parte del mismo.
- Hacen referencia a que *"las mediciones ecográficas serán realizadas por un mismo científico, especialista en dichas valoraciones"*. ¿Qué especialista realizará las evaluaciones ecográficas?
- Análisis estadístico: ¿Cómo se definió el tamaño muestral? ¿Qué estrategia se define para superar posibles pérdidas de muestras (ej. por personas que abandonen y/o interrumpan (ej. por enfermedad) la intervención? ¿Qué

estrategia se define para equiparar (ej. al inicio) los seis sub-grupos, o no serán equiparados? ¿Cómo se trabajará considerando diferencias en dad, sexo, condición cardio-respiratoria y de entrenamiento previo, exposición a factores de riesgo, consumo de fármacos, etc.? ¿Cómo se evaluará el efecto ´crónico´ de la intervención (como se menciona en el objetivo), si las evaluaciones se realizarán inmediatamente antes y después de finalizada la misma? ¿Cómo se definirán los ´respondedores vs. no-respondedores´ a la intervención.

En el proyecto, sería conveniente incluir información sobre: investigadores participantes, equipamiento disponible, lugar donde se encuentra, y responsable del mismo; resultados esperados, factibilidad. Adicionalmente mencionar, de requerirse, la fuente de financiamiento del proyecto.

Por otra parte, a la hora de presentar en un Plan de Trabajo de un período de tres años de un docente que aspira a ingresar al Régimen de DT, los aspectos relacionados con la Investigación, deberían detallarse aspectos que trasciendan un proyecto de investigación específico. Como ejemplo, hay aspectos relacionados con la investigación que refieren a (i) líneas temáticas (conceptuales) de trabajo, (ii) proyección para adquisición de equipamiento y/o construcción de capacidades (ej. laboratorios), (iii) estrategias de consecución de financiamiento, (iv) abordaje para atraer y formar recursos humanos en investigación científica, etc., que deberían ser abordados como parta de una planificación.

Enseñanza

En el apartado de "Enseñanza" se menciona que participarán como colaboradores (aparentemente del proyecto de investigación mencionado) estudiantes de 4to año de la Licenciatura en Educación Física, que estén cursando la asignatura "Seminario de Tesina Salud 2024". Además, que participarán dos alumnos de Maestría PEDECIBA. No es claro el rol que tendrán estos estudiantes en el proyecto.

Por otra parte, en opinión de este evaluador, deberían describirse actividades más específicas sobre lo que se plantea hacer en términos de Enseñanza Universitaria, sea de grado o posgrado.

Tal como está escrito, el apartado "Enseñanza" parece una continuación del proyecto de investigación, ya que hace mención a quienes "colaborarán" en el proyecto.

Se plantea que se realizará una ´Estancia Pos-doctoral ´en la California State University (CSUSM). Como se plantea dentro de un Plan de Trabajo, deberían indicarse los objetivos de esa estancia fuera del país, en el contexto de lo planificado.

Extensión

Se menciona que se aspira a crear un espacio de formación integral (EFI) dentro del Hospital de Clínicas, que sea modelo a nivel nacional en rehabilitación cardiometabólica; se plantea que esto es una cuestión claramente necesaria y sin precedentes. Se plantea que en el mismo, se desarrollará de manera conjunta las tres funciones de la UdelaR junto a diversas carreras (educación física, nutrición, medicina, etc.) y la comunidad de funcionarios.

En opinión de este evaluador la idea es valorable. Sin embargo, desde el momento en que lo planificado es principalmente destinado a ser montado en otro servicio (Hospital de Clínicas), en el que ya existen autoridades que se encargan de los abordajes de diagnóstico y terapéutica de la salud cardiovascular, debería contarse con el Aval de las autoridades del mismo, para su aceptación; más si se menciona que lo planteado no tiene precedentes.

Relacionado con lo anterior, se plantea que se procurará "avanzar en una modalidad en auge como es la tele rehabilitación, para llegar al interior dónde la UdelaR tiene presencia". Deberían darse detalles de cómo se planifica trabajar en este aspecto.

Comentarios adicionales

Un aspecto que no se menciona y que sería interesante abordar, es sobre el plan que el docente tiene en cuanto a interacción y/o integración con otros grupos y sub-grupos existentes en el propio ISEF y la UdelaR (ej. Montevideo [varios], Maldonado, Paysandú, Rivera), que trabajan en áreas y temáticas relacionadas. Tal como está planteado el Plan de Trabajo, no se planifica interaccionar con esos grupos que trabajan en áreas relacionadas, incluso dentro de la propia Institución. Pensando en el propio desarrollo del postulante, pero fundamentalmente de la institución ISEF y de la UdelaR, sería importante en opinión de este evaluador fomentar que en los propios planes de trabajo los docentes (investigadores) diseñen y expliciten formas de interacción potenciadora. Esto permite optimizar recursos económicos, humanos, instalaciones, etc., y ´hacernos mejores´ tanto institucionalmente como profesionales.

Comentario final

Ateniendo lo planteado en el Artículo 74, 79 y 80, a mi entender es un docente que tiene fundadas aspiraciones a ingresar al Régimen de Dedicación Total, basadas en sus antecedentes y vocación. Claramente en mi opinión, el ISEF y la UdelaR se enriquecerían al contar con un profesional de estas características en sus planteles, desempeñando un cargo de Dedicación Total. No obstante, en mi opinión, la propuesta debe ser mejorada, aspirando a que profundizar y enriquecer la misma, sea formativa para el postulante, haciéndolo ver que se solicita mayor profundidad, especificidad e integralidad de su Plan de Trabajo.

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INFORME DE LA COMISIÓN DE DEDICACIÓN TOTAL DEL ISEF
Nº de expediente: 008440-000023-24
Solicitud de ingreso al Régimen de DT del docente Stefano Benitez

La Comisión de Dedicación Total de ISEF consideró la solicitud de ingreso presentada por el Dr. Stefano Benitez. En virtud del plan de actividades presentado, los méritos del aspirante y la evaluación externa solicitada, esta Comisión entiende que:

El postulante reúne méritos suficientes para ingresar al régimen de Dedicación Total, contando con formación y trayectoria de investigación suficiente. Tiene un Doctorado en Educación Física y cuenta con experiencia en proyectos de investigación en temáticas vinculadas a su Plan de Actividades. Además, integra el Sistema Nacional de Investigadores y el Programa de Desarrollo de las Ciencias Básicas. Se destaca el trabajo interdisciplinario y sus vínculos académicos nacionales e internacionales. Sin embargo, no se inscribe con claridad en un Grupo de investigación de ISEF que permita abonar de forma conjunta a la producción coordinada con investigadores del área, aprovechando y acumulando recursos existentes y contribuyendo a su desarrollo.

Respecto a su Plan de actividades, esta Comisión entiende que su estructura corresponde prioritariamente a la de un proyecto de investigación y no a un plan integral de actividades. Se destaca la importancia de incorporar actividades más detalladas en todas las funciones universitarias. Se sugiere tanto matizar algunas afirmaciones respecto a la magnitud del impacto y novedad el proyecto de investigación a realizar, así como explicitar la viabilidad del mismo. Si bien no se espera que un plan de trabajo en el marco de una solicitud de ingreso al Régimen de DT detalle cada uno de los aspectos de un proyecto de investigación, parece necesario incorporar información sobre algunas variables e indicadores a utilizar y sus posibilidades de control, aspecto que hace a la viabilidad y validez de la investigación proyectada. Esta Comisión entiende que las actividades de enseñanza y de extensión deben ser mayormente detalladas y sugiere especialmente la vinculación del docente con las estructuras de investigación existentes en el ISEF.

Por lo anteriormente mencionado, esta Comisión entiende que es necesario la reformulación del Plan de actividades atendiendo a las consideraciones señaladas.

Se adjunta el informe externo solicitado a un especialista en la temática.

Cecilia Seré

Mg. Gonzalo Pérez Monkas

Inés Scarlato

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4723 8342-int 107

	Expediente Nro. 008440-000023-24 **Actuación 3**	Oficina: SECCIÓN PERSONAL - CENTRO MONTEVIDEO - ISEF Fecha Recibido: 27/05/2024 Estado: Cursado

TEXTO

Se adjunta plan de actividades y nota de Stefano Benitez.

13/6/24 - Vuelva a Comisión de Dedicación Total.-

Firmado electrónicamentemente por ALICIA GRISEL ROSAS PENA el 13/06/2024 08:42:40.

Nombre Anexo	Tamaño	Fecha
Notificación EXP 008440-000023-24.pdf	160 KB	12/06/2024 13:41:35
NotaBenitez.pdf	26 KB	12/06/2024 13:41:35
PlandeActividades.pdf	103 KB	12/06/2024 13:41:35

Gmail **Sección Personal ISEF <personal.isef@gmail.com>**

Notificación EXP 008440-000023-24

2 mensajes

Sección Personal ISEF <personal.isef@gmail.com> 29 de mayo de 2024, 8:54 a.m.
Para: Stefano Benítez Flores <stefanobenitez@gmail.com>

Buenos días,

Solicitamos por este medio se dé por notificado con el siguiente diálogo "Me doy por notificado NOMBRE Y CI"

Se adjuntan informes.

Gracias.

Saludos cordiales

Sección Personal ISEF

2 archivos adjuntos

Evaluación_DT_StefanoBenítez_especialista.pdf
57K

Informe solicitud DT Benitez.pdf
221K

Stefano Benítez Flores <stefanobenitez@gmail.com> 29 de mayo de 2024, 11:12 a.m.
Para: Sección Personal ISEF <personal.isef@gmail.com>

Buen día.

Me doy por notificado CI 38916289 Stefano Benítez.

Por otra parte, me están solicitando reformular el plan de trabajo entonces me gustaría saber que procedimiento debo seguir.

Saludos cordiales.

Stefano Benítez-Flores, Ph.D.
Departamento de Educación Física y Salud
Instituto Superior de Educación Física (ISEF)
Universidad de la República
Montevideo, Uruguay
ORCID
Research ID

[Texto citado oculto]

Montevideo, 12 de junio de 2024

Sres/Sras Miembros de la comisión de Dedicación Total de ISEF, Uruguay:

A través de la presente me comunico con ustedes para expresarles que me he tomado el tiempo para reformular totalmente el plan de trabajo de acuerdo a las sugerencias de la comisión y del evaluador/a externo. Entiendo los puntos colocados y que lo que se presento no era un plan de actividades descriptivo de todas las funciones que tiene que brindar un docente en la Udelar. Por otra parte, he tomado todas las oportunas sugerencias recibidas por el revisor/a externo específicamente del proyecto de investigación (se puede ver un enlace al mismo en el plan de actividades), en algunas oportunidades no se detallaron los procedimientos por una limitación de espacio. En cuanto, a la preocupación que manifiesta la comisión de mi involucramiento interno en ISEF, solo me queda por comentar que mantengo colaboraciones dentro del Departamento de Salud y con el Departamento de Deporte. También he interaccionado en varias oportunidades con investigadores/as de Paysandú. No obstante, me encuentro en una fase de consolidación como investigador independiente generando una nueva línea de investigación dentro de ISEF, que va a generar oportunidades para los alumnos/as, con colaboraciones nacionales e internacionales. Por último, como sabrán esta es la segunda vez que presento mi proyecto de DT, la primera fue hace ya 4 años por lo que pido contemplación en la celeridad de los procesos.

Gracias por su tiempo y por la posibilidad de responder.

Saludos cordiales

Stefano Benítez Flores

Universidad de la República

ISEF

Hospital de Clínicas

2024

Plan de Actividades DT

Dr. Stefano Benítez-Flores

Resumen

Este plan de trabajo se va a desarrollar dentro del núcleo biológico, siendo una parte del grupo de Investigación en Educación Física y Salud CSIC (883103), el cual coordino junto al Dr. Carlos Magallanes. El núcleo ha potenciado su trabajo interdisciplinario, cuestión clave para el abordaje de cualquier problemática vinculada con la salud. Desde mi apreciación, es natural que cualquier investigador/a que culmina un doctorado y retorna al país, quiera desarrollar su propia línea/equipo de investigación enfocado en su experiencia formativa e intereses. Actualmente, me encuentro coordinando un equipo junto al Dr. Federico Ferrando dentro del Hospital de Clínicas (HDC), que está instaurando programas de rehabilitación cardiometabólica (no existentes en dicho centro) para pacientes y funcionarios/as. Esto diversifica y enriquece las áreas de estudio del propio ISEF. La rehabilitación cardiometabólica es un programa, que complementa la rehabilitación tradicional (farmacológica), compuesto por intervenciones interdisciplinarias tales como; actuación psicológica, seguimiento nutricional, aspectos educativos sobre la enfermedad, control de los factores de riesgo y actividad física (AF) (siendo esta la piedra angular). Los pacientes que integran los programas de rehabilitación cardiometabólica muestran longitudinalmente reducciones en los reingresos hospitalarios, futuros eventos cardiacos y mortalidad, además de una clara mejora en la calidad de vida. En este espacio participa también el Área de Fisiatría, la Unidad de Sueño y la Escuela de Nutrición lo que permite un abordaje multifocal. La consolidación de un equipo interdisciplinario permitirá obtener múltiples beneficios, tanto a nivel de investigación como en asistencia y docencia. En términos docentes, se observa una mayor necesidad de desarrollo de académicos/profesionales que puedan intervenir con AF en la prevención primaria y secundaria, conociendo que tipo de modalidad puede tener una mejor eficacia para la reducción de factores de riesgo cardiometabólico. Aquí van a realizar las tesis de maestría bajo mi cotutela 2 alumnos de PEDECIBA (uno de ellos becario ANII) con proyectos ya aprobados por el comité de ética del HDC. También, próximamente un tercer alumno presentará su proyecto al comité de evaluación de PEDECIBA (dicho alumno es G1 del ISEF). Además, durante el año 2024 se tomó un Seminario Tesina del trayecto Salud de la LEF, con foco en la prevención y tratamiento de las enfermedades cardiometabólicas. Aspiramos a que parte de estos/as alumnos/as puedan cursar futuramente la Especialización en Ejercicio Físico Adaptado (la cual colaboré con el programa y se encuentra en vías de implementación por ISEF) o maestrías dentro de PEDECIBA o ProMEF (en el caso de que se me habilite como orientador). También, se espera que dichos estudiantes se unan al plantel docente del ISEF. Adicionalmente, durante el segundo semestre del 2024 se va a dictar un curso de PEDECIBA/ProMEF denominado Ejercicio físico para la Prevención y Tratamiento de Enfermedades Crónicas No Transmisibles, que va a tener la participación del Dr. Carlos Magallanes y el Dr. Eduardo Cadore de la UFRGS. Esta asignatura de posgrado se va a sumar al Seminario de Tesis del ProMEF, que participo hace ya tres ediciones. Por otra parte, buscaré transferir los conocimientos producidos a las aulas de la asignatura Fundamentos Anatomo Fisiológicos (FAF), con el objetivo de tener un abordaje actualizado de la Fisiología, dotando las aulas de experiencias prácticas que le sirvan a los estudiantes como herramientas para el campo profesional; conjuntamente me parece fundamental que en fases iniciales de la LEF los/las alumnos/as tengan contacto con la ciencia. Por último, se propone desarrollar la extensión universitaria generando un EFI dentro del HDC, que sea modelo a nivel nacional en rehabilitación cardiometabólica; cuestión claramente necesaria dado que, por ejemplo, en Uruguay sólo el 4% de la población con indicación de rehabilitación cardiovascular accede a la misma (siendo las enfermedades cardiovasculares la principal causa de mortalidad). En este lugar forjando I+D, se pretende brindar rehabilitación a poblaciones muchas veces marginalizadas por su baja condición física y con escasos recursos económicos para poder solventar un tratamiento a largo plazo. En este espacio, también se pretende incluir programas de rehabilitación para los/las funcionarios/as del HDC, buscando optimizar su bienestar físico/psicológico y reducir el ausentismo laboral.

Investigación

Introducción

Este plan de trabajo ya fue aprobado por el Departamento de Salud (ISEF), se va a desarrollar dentro del núcleo biológico, como un proyecto del grupo de Investigación en Educación Física y Salud CSIC (883103) que coordino junto al Dr. Carlos Magallanes. El núcleo biológico ha diversificado sus áreas de estudio, tendiendo puentes y potenciando el trabajo interdisciplinario. De esta manera, me encuentro en una fase de consolidación como investigador independiente, generando líneas nuevas para el país centradas en el impacto de la AF estructurada (ejercicio físico) en la salud. Actualmente, estoy desarrollando un centro de rehabilitación cardiometabólica interdisciplinario en el Hospital de Clínicas (HDC) junto al Dr. Federico Ferrando, conformado por el Área de Fisiatría (Dr. Gerardo Amilivia), la Unidad de Sueño (Dra. Ana Musetti) y la Escuela de Nutrición (Dra. Estela Skapino y Dra. Marcela Guerendiain), que va a centrarse en la rehabilitación física siguiendo las guías europeas (1). Dicho centro ya cuenta con una planta física otorgada y equipamiento de gimnasio de última generación (https://www.technogym.com/). Tiene también instrumentos para medir la función autonómica cardiovascular (https://www.firstbeat.com/en/), acelerómetros para medir la AF y el Sueño (https://theactigraph.com/) y bioimpedancia para medir la composición corporal (https://www.omron.com/global/en/) otorgados por fondos I+D CSIC. Además, equipos para medir la función neuromuscular (https://www.ivolution.com.ar) comprados con el fondo despegue científico PEDECIBA. También, con motivos de comprar un analizador de gases (https://vo2master.com/) se postuló al fondo de equipamiento de PEDECIBA. En dicho centro se cuenta con diversos equipos para el diagnóstico de enfermedad cardiovascular tales como; centellografía, ecocardiografía, electrocardiografía, etc. Por último, se pactó con la escuela de nutrición usar su DEXA (https://www.hologic.com/). Para continuar mejorando las condiciones del centro, se presentó una propuesta al llamado Institutos de Investigación (CSIC) y se proyecta postularse al programa de equipamiento científico (ANII). Sumado a mi proyecto de dedicación total, aquí van a realizar las tesis de maestría bajo mi cotutela 3 alumnos de PEDECIBA (uno de ellos becario ANII, otro aceptado que proyecta postularse a becas de posgrados nacionales ANII y otro que proyecta postularse y buscará una beca de apoyo a docentes CAP). Se espera que dichos alumnos sean parte del plantel docente del ISEF, de hecho, participaron de concursos y uno de ellos ya es docente del núcleo biológico. También, se van a acoplar algunos/as alumnos/as del Seminario Tesina Salud para realizar proyectos de finalización de la LEF. Uno/a de ellos/as se procurará integrarlo a nuestro equipo mediante el llamado PREXI (PEDECIBA). Se espera que el/la mismo/a continue luego con su maestría. Por último, se planea seguir manteniendo la colaboración científica intra e inter-departamental dentro de ISEF tal cual se manifiesta en mi CVuy.

Antecedentes

El foco de mi línea de estudio surge a partir de las enormes potencialidades que tiene la AF hacia la salud. Se sabe que la práctica de AF es la única terapia que induce efectos multisistémicos, es de bajo coste económico, puede ser adaptable a cualquier población y si es bien dosificada no provoca efectos secundarios (2). Estudios de cohorte prospectivos evidenciaron que mayores niveles de AF, se asocian a un menor riesgo de enfermedad por cualquier causa y un aumento en la expectativa de vida (3,4). Sin embargo, un 25% de los adultos y un 80% de los adolescentes no cumple con las recomendaciones de AF (5). En Uruguay este fenómeno se vislumbra, dado que un 25% de la población no alcanza las recomendaciones de AF; hallándose notoriamente una peor respuesta en las mujeres, y las porciones de mayor edad, mayor pobreza o bajo nivel educacional (6). La inactividad física es el cuarto factor de riesgo de mortalidad y se ha estimado que causa 5,3 millones de muertes por año, costando al menos U$$54 mil millones en costos directos médicos, de los cuales U$$31 mil millones son pagados por el sector público (7). En países cercanos tales como Argentina, fue calculado que entre el 0.61 y el 1.48 del PIB son pérdidas económicas asociadas a la inactividad física (8). Solo

el aumento del número de pasos diarios a 6.500 pasos/día, se asocia con una reducción del 49 % de mortalidad por enfermedades cardiovasculares (9).
La falta de tiempo, la escasa motivación y la inaccesibilidad (instalaciones y costos financieros) son mencionadas como barreras para no practicar AF (10,11). Es necesaria la investigación de nuevas terapias que puedan contemplar dichas barreras simplificando y masificando la AF (12). En este sentido, el entrenamiento interválico, se ha consolidado como una gran terapia física, ya que según numerosos meta-análisis con un menor compromiso de tiempo semanal, ha manifestado notables beneficios para la salud en poblaciones saludables y no saludables (13,14,15,16). El entrenamiento interválico consiste en la ejecución de intervalos de alta intensidad (de 5 s a 4 min), con recuperaciones activas/pasivas entre los mismos, permitiendo sostener al organismo un mayor tiempo en zonas de alta demanda cardiorrespiratoria. La intensidad es clave para activar vías de señalización que inducen adaptaciones fisiológicas centrales y periféricas (17). Dentro del entrenamiento interválico, sesiones muy cortas (iguales o menores a 15 min) han demostrado su eficiencia en mejorar parámetros cardiometabólicos tales como; VO_2max, grasa corporal, presión arterial, etc. (18). Más recientemente, ha surgido el interés por el entrenamiento funcional de alta intensidad (HIFT), dónde se hacen ejercicios multiarticulares de fuerza con el propio peso corporal tales como; *burpees, mountain climbers, jumping jacks, etc*. Dichos modelos, inducen efectos mixtos cardiorrespiratorios y neuromusculares superiores a los protocolos convencionales de entrenamiento interválico o entrenamiento continuo de moderada intensidad (MICT) (19). Por lo tanto, mi investigación apunta a indagar el impacto agudo/crónico en variables físicas, fisiológicas y clínicas ligadas a la salud cardiometabólica, de diversos modelos de entrenamiento interválico de bajo volumen versus modelos convencionales (MICT o entrenamiento concurrente) dentro de programas multifocales (actuación psicológica, nutricional, etc.), en ambientes hospitalarios con poblaciones inactivas o patológicas.

Objetivos

1) Consolidar un centro de prevención y rehabilitación cardiometábolica en el HDC
2) Estructurar programas de prevención y rehabilitación cardiometabólica basados en evidencia, que sirvan para mejorar la calidad de vida de los pacientes o funcionarios/as del HDC
3) Generar conocimiento de alto nivel que jerarquice los servicios vinculados

Acciones a implementar

1) Consolidación del centro de prevención y rehabilitación cardiometabólica del HDC, mejora de la planta física e incorporación de nuevos equipamientos
2) Difusión en el centro hospitalario y reclutamiento de participantes
3) Ejecución de proyectos aprobados por alumnos PEDECIBA (Diego Ferraro, Darío Trujillo) y mi proyecto personal de dedicación total (Stefano Benítez)
4) Integración de alumnos/as del Seminario Tesina Salud al grupo de investigación
5) Publicación de artículos y participación en congresos internacionales
6) Difusión de resultados en jornadas académicas abiertas a todo público

Resultados esperados

1) Rehabilitación de participantes y promoción de hábitos saludables
2) Generación de conocimiento de alto nivel y de futuros investigadores/as
3) Difusión de resultados para que el conocimiento sea aplicado en otros centros de salud

Enseñanza

Se planifica realizar 2 cursos de grado durante 2024-2025:

1) Fundamentos Anatomo-Fisiológicos (FAF) (80 horas, corresponsable): Se pretende mantener la carga de 3 masivos y 5 reducidos. Dicha materia ha tenido un cambio sustancial en su funcionamiento, dado que existe un equipo que funciona de manera

coordinada y organizada, que ha permitido mejorar la gestión de la asignatura, así como también las tasas de aprobación. Además, en una encuesta reciente sobre los planes de estudio, los estudiantes han manifestado que consideran a FAF como una de las asignaturas más importante de la licenciatura, lo que denota el valor que tiene dentro del tronco común. También, en una encuesta realizada durante el 2022 se manifiesta la conformidad de los/las alumnos/as con el funcionamiento de la asignatura (encuesta). Lamentablemente FAF aún esta carente de profesores en relación a otras asignaturas del primer semestre que tienen una similar carga horaria, lo que sobrecarga al equipo docente no pudiendo mejorar aún más las condiciones. Por último, es llamativo la carencia de grados superiores (mayores a G2), a pesar de la masividad de FAF y la dificultad que tiene dar 2 asignaturas diferentes compactadas en una semestral. Este elemento fue señalado en un informe por el equipo docente presentado durante el 2022 (informe).

2) Seminario Tesina Salud Actividad física, Aptitud física y Salud (50 horas, responsable): Se pretende mantener 1 reducido. El seminario tesina apuesta a formar académicos/profesionales en el área de ejercicio físico aplicado a la mejora de la salud. Esto va a permitir consolidar mi línea de investigación a nivel nacional, ampliando el número de proyectos de investigación y la colaboración con otros centros/facultades en el contexto Udelar u otros centros internacionales. Dicho seminario ocupo todos los lugares disponibles durante el 2024, lo que indica un interés importante por parte de los/las alumnos/as en los tópicos planteados. Durante el año 2021 la ejecución de dicho seminario generó 2 artículos en revistas internacionales (DOI, DOI).

Se planifica realizar 2 cursos de formación permanente durante 2024-2025:

1) Actuales tendencias en el ámbito del fitness para mejorar la aptitud física (15 horas, responsable)
2) Evaluación y monitorización de la condición física en poblaciones entrenadas y desentrenadas (15 horas, responsable)

Se planifica realizar 2 cursos de posgrado durante 2024-2025:

1) Seminario de Tesis ProMEF (30 horas, corresponsable). Equipo: Sabrina Cervetto, Gonzalo Pérez, Andrés González, Ana Torrón, Javier Salvo, Camilo Ríos, Stefano Benítez.
2) Ejercicio Físico para la Prevención y Tratamiento de Enfermedades Crónicas No Transmisibles ProMEF, PEDECIBA (30 horas, corresponsable). Equipo: Carlos Magallanes, Eduardo Cadore (UFRGS), Stefano Benítez.

Se planifica participar de cursos de las especializaciones aprobadas en Ejercicio Físico Adaptado y Rendimiento Deportivo de ISEF (aún no definidas asignaturas y programas).

Se planifica presentarse a las siguientes convocatorias durante 2024:

1) Creación de Institutos de Investigación (CSIC)
2) Fondo de equipamiento (PEDECIBA)
3) Programa PREXI (PEDECIBA)
4) Programa MIA (CSIC)
5) Becas posgrados nacionales (ANII)
6) Becas de apoyo a docentes (CAP)
7) Fondo María Viñas (ANII)
8) Fondo de Equipamiento (ANII)

Se planifica realizar las siguientes estancias posdoctorales con el objetivo de mejorar la calidad docente e investigadora durante 2024-2025:

1) Estancia posdoctoral 2024 en la *University San Marcos, California, US*. Dicha estancia posdoctoral será dirigida por el Dr. Todd Astorino quien mantenemos una colaboración desde el año 2021, que ha permitido la publicación en conjunto de 4 artículos en revistas indexadas. El Dr. Astorino es el investigador con mayor número de

publicaciones en el campo del entrenamiento interválico. El propósito de dicha instancia es acompañar los estudios del Dr. Astorino sobre los efectos agudos/crónicos de diversas modalidades de entrenamiento interválico. Esto me va a permitir perfeccionar la aplicación de dicha metodología en múltiples poblaciones. Durante dicha estancia se realizará una visita a *McMaster University*, considerada una de las mejores del mundo en ciencias del ejercicio, pionera en la aplicación de entrenamiento interválico de esprints (SIT).

2) Estancia posdoctoral 2025 en la *Universidade Federal Paulista* dentro del laboratorio *Exercise and Chronic Disease Research Laboratory.* Esta estancia posdoctoral será dirigida por el Dr. Emmanuel Gomes Ciolac, quién es un referente mundial en la aplicación de entrenamiento interválico para poblaciones con enfermedades cardiometabólicas. Dicha instancia me permitirá profundizar en el conocimiento y manejo de las enfermedades cardiometabólicas, así como en la dosificación de entrenamiento interválico para poblaciones con las mencionadas enfermedades.

Se planifica participar de los siguientes congresos internacionales con el objetivo de mejorar la calidad docente e investigadora durante 2024-2025:

1) *ACSM's and Idea Health & Fitness Association 2025, Orlando, US*
2) *ECSS 30th Annual Congress 2025 Rimini, Italia*
3) Congreso Uruguayo de Cardiología 2024-2025 Montevideo, Uruguay
4) XX Encuentro de Investigadores en Educación Física de Uruguay (1994–2024) Montevideo, Uruguay
5) Congreso Internacional de Nutrición y Deporte INANS (2024) Rio de Janeiro, Brasil
6) *18th International Symposium of 3-D Analysis of Human Movement* Montevideo, Uruguay.

Extensión

Se aspira a crear como corresponsable un EFI dentro del HDC, que sea modelo a nivel nacional en rehabilitación cardiometabólica desde un abordaje interdisciplinario. Creemos que es una cuestión claramente necesaria dado que solo un 4% de la población con indicación de rehabilitación cardiovascular accede a la misma. Este dato nos posiciona muy lejos a nivel regional de países como Brasil donde accede el 22% (20). Para esto se presentó una propuesta a la creación de Institutos de Investigación (CSIC). En el mismo, se desarrollará de manera conjunta las tres funciones de la Udelar junto a diversas carreras (educación física, nutrición, medicina, etc.) y la comunidad de funcionarios/as. El sedentarismo junto a sus problemas asociados de salud, son una nefasta pandemia (7), siendo el ejercicio físico una real polipíldora (2). La inclusión de pacientes y funcionarios/as va a permitir que puedan mejorar su bienestar físico/psicológico, junto con su productividad y ausentismo laboral. En relación a los pacientes, es importante considerar que en el HDC se atienden las poblaciones más vulnerables, que no tienen posibilidades económicas para acceder a centros de rehabilitación de cualquier índole.
Por otra parte, en relación a los funcionarios/as, con motivos de practicidad, esta propuesta se enmarca en el lugar convencional de trabajo, lo que va a facilitar el acceso; dado que se ha descrito en la literatura que los costos asociados al transporte y la falta de tiempo (10,11), son una barrera importante para no involucrarse en programas de AF. Igualmente, un propósito implícito de este EFI, es cultivar estilos de vida saludables, que puedan repercutir en la morbimortalidad y el gasto sanitario (fármacos, diagnósticos, cirugías, etc.) (7). De esta manera, se procurará la educación del núcleo familiar, por el motivo de que es un elemento clave para reproducir y mantener las rutinas a largo plazo. También, se pretende extender y difundir los resultados desde los programas intrahospitalarios a diversos centros/facultades Udelar, así como también a instituciones y colectivos como los espacios de recreación y deportivos públicos; para que se puedan generar propuestas hacía poblaciones marginalizadas, por su baja condición física o situación patológica y el desconocimiento de que tipo de AF es

apropiada para su problemática en particular. Finalmente, se procurará avanzar en una modalidad en auge como es la telerehabilitación, para llegar al interior dónde la Udelar puede tener más presencia. Esto también permitiría llegar a poblaciones rurales que carecen de espacios de segundo nivel de atención. Esta es una idea clara del equipo, pero aún carece de maduración, dado que el objetivo inmediato es fortalecer la planta física ya otorgada por el HDC.

Objetivos

1) Crear un EFI de rehabilitación cardiometabólica en dónde se puedan atender pacientes y funcionarios/as del HDC, formando a la vez alumnos/as de grado y posgrado
2) Disminuir los costos asociados a fármacos y tratamientos que tiene el HDC, promoviendo estilos de vida saludable

Acciones a implementar

1) Creación del EFI y difusión en el ámbito intrahospitalario
2) Difusión de proyectos y reclutamiento de participantes dentro del HDC
3) Ejecución de proyectos vinculados al EFI con estudiantes de diversas carreras dentro del HDC
4) Ejecución de las siguientes actividades académicas:
    - Difusión de resultados en otros centros ASSE para ampliar los programas de rehabilitación cardiometabólica
    - Difusión de resultados en las facultades involucradas a los proyectos para captar capital humano y ampliar las líneas de investigación
    - Creación de guías de recomendaciones para que puedan ser implementadas en otros centros a nivel nacional

Resultados esperados

1) Consolidación del EFI y correcta ejecución de los proyectos
2) Extensión de los resultados a otros centros para fomentar la rehabilitación cardiometabólica

Gestión

Se planifica continuar con la colaboración en la gestión y mejora de FAF, materia altamente numerosa y que ha mejorado su funcionamiento en los últimos años. En cuanto a la gestión directa, estaré dispuesto a asumir el cargo que el departamento o la institución crea conveniente, cumpliendo el rol que pueda ayudar de mejor forma al deseado crecimiento del ISEF.

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20) de Cardiología, S. A. (2019). *Rev Arg Card*, *87*(3), 1-57. https://www.sac.org.ar/consenso/consenso-argentino-de-rehabilitacion-cardiovascular/

	Expediente Nro. 008440-000023-24 **Actuación 4**	Oficina: COMISIÓN DE DEDICACIÓN TOTAL - CENTRO MONTEVIDEO - ISEF Fecha Recibido: 13/06/2024 Estado: Cursado

TEXTO

Montevideo, 17 de Julio de 2024.-

Se adjunta informe de la Comisión de DT, pase a la UGP por así corresponder.-

Firmado electrónicamentemente por NOELIA ALMEDA PEREIRA el 17/07/2024 08:59:16.

Nombre Anexo	Tamaño	Fecha
Benitez comision DT.pdf	474 KB	17/07/2024 08:58:46

isef
Instituto Superior
de Educación Física
UNIVERSIDAD DE LA REPÚBLICA

Montevideo 15 de julio de 2024

Estimados miembros de la Comisión Directiva del ISEF

Recibido un nuevo plan de actividades del docente Stefano Benítez para solicitar el ingreso al Régimen de Dedicación Total, se realizan algunas valoraciones considerando las sugerencias que ésta Comisión le hizo al aspirante en su primera presentación:

a) El aspirante explicita su participación en el grupo de Investigación en Educación Física y Salud (Grupo CSIC n.º 883103) que coordina junto al Dr. Carlos Magallanes.

b) La propuesta logra explicitar con mayor claridad la viabilidad y validez de la investigación proyectada en la medida que incorpora información sobre algunas variables e indicadores a utilizar así como sus posibilidades de control.

c) Se aporta nueva información relativa a las actividades de enseñanza y extensión que le otorgan al plan una mirada más amplia que la de un proyecto de investigación específico.

Por lo expuesto esta comisión entiende que las modificaciones realizadas son adecuadas y sugiere a la Comisión Directiva de ISEF que proponga al Consejo Directiva Central el ingreso de Stéfano Benítez al Régimen de DT en un cargo de Asistente (Gº2).

INÉS SCARLATO Cecilia Seré Gonzalo Pérez

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4225 5326 (telefax)

Rivera CUR
Ituzaingó 667
462 26313

Paysandú CUP
Florida 1065
4723 8342-int 107

TEXTO

Montevideo, 17de juliode 2023.

Exp.008440-000023-24

La Unidad de Apoyo a la Gestión Presupuestal y Contable (UGP) informa que:

El Sr. Stefano Benitez tomó posesión de un cargo, Esc. G, G°2, 20 horas, de carácter interino (N°556184) el dia 03/04/20. Por expediente N°008440-000549-23 se prorrogó su cargo hasta el 31/12/24.

Por expediente N°008440-000092-24, se le otorgó una extensión horaria de 20 a 30 horas, por el periodo 01/04/24 al 31/12/24.

El ISEF financiará 30 horas.

Pase a Sección Personal para incluir carrera funcional actualizada, cumplido siga a División Contaduría de Oficinas Centrales.

Firmado electrónicamentemente por Walter Antonio Da Luz Varela el 17/07/2024 16:32:04.

	Expediente Nro. 008440-000023-24 **Actuación 6**	Oficina: SECCIÓN PERSONAL - CENTRO MONTEVIDEO - ISEF Fecha Recibido: 17/07/2024 Estado: Cursado

TEXTO

SE adjunta Carrera Funcional actualizada.

Pase a División Cobtaduría Central, según lo dispuesto

Firmado electrónicamentemente por ALICIA GRISEL ROSAS PENA el 19/07/2024 07:50:05.

Nombre Anexo	Tamaño	Fecha
CarreraFuncional_Stefano_Benitez_20240719074831_38916289.pdf	22 KB	19/07/2024 07:49:34

RRHH - Sueldos y Personal

Universidad de la República - ISEF

Carrera Funcional

Benitez Flores, Stefano - Documento: 38916289

Nº CARGO	DENOMINACIÓN	CATEGORÍA	ESC/SUB	CARRERA	CARÁCTER	FORMA DE ACCESO	GRADO	HORAS
556184	Asistente	Docente	G.0.01	Docente	Interino	Llamado aspirantes	2	20

INSTITUCIONAL: 26.001.550.07.04.01 - MVD/ EFySalud/ Fundamentos Biológicos

PARTIDA PRESUPUESTAL: 155110100 - ISEF Centro Montevideo

MOVIMIENTO	ÓRGANO EMISOR	Nº RESOLUCIÓN	FECHA RESOL.	Nº EXPEDIENTE	FECHA DESDE	FECHA HASTA	HORAS	PORCENT.	PART. PRESUPUESTAL
Designación (Docente)	Comisión Directiva	74	03/04/20	008150-000183-20	03/04/20	31/03/21			155110100
Prórroga en el Cargo	Comisión Directiva	49	26/02/21	008440-501734-20	01/04/21	31/03/22			155110100
Prórroga en el Cargo	Comisión Directiva	30	25/03/22	008440-503414-21	01/04/22	31/03/23			155110100
Prórroga en el Cargo	Comisión Directiva	7	31/03/23	008440-000610-22	01/04/23	31/03/24			155110100
Prórroga en el Cargo	Comisión Directiva	30	05/04/24	008440-000549-23	01/04/24	31/12/24			155110100
Extensión Horaria Docente	Comisión Directiva	57	08/05/20	008440-000968-20	01/05/20	31/03/21	20-29		155110100
Extensión Horaria Docente	Comisión Directiva	15	20/10/20	008150-500106-20	01/10/20	25/12/20	29-39		155110200
Extensión Horaria Docente	Comisión Directiva	45	09/04/21	008150-500290-21	01/04/21	31/03/22	20-23		155110100
Extensión Horaria Docente	Comisión Directiva	36	03/05/24	008440-000092-24	01/04/24	31/12/24	20-30		155110100
Licencia Con Goce de Sueldo	C.D.A.	38	13/09/22	008440-000397-22	30/08/22	08/12/22			
Licencia Con Goce de Sueldo	Director de Departam	1	15/05/24	LECGS S.BENITEZ	22/05/24	23/05/24			

Nº CARGO	DENOMINACIÓN	CATEGORÍA	ESC/SUB	CARRERA	CARÁCTER	FORMA DE ACCESO	GRADO	HORAS
556110	Asistente	Docente	G.0.01	Docente	Contratado	Designación directa	2	20

INSTITUCIONAL: 26.001.550.06.04.01 - Centro Montevideo

PARTIDA PRESUPUESTAL: 155110200 - ISEF Centro Montevideo Prog102

MOVIMIENTO	ÓRGANO EMISOR	Nº RESOLUCIÓN	FECHA RESOL.	Nº EXPEDIENTE	FECHA DESDE	FECHA HASTA	HORAS	PORCENT.	PART. PRESUPUESTAL
Designación (Docente)	C.D.C.	8	04/06/19	008050-000097-19	13/06/19	31/12/19			155110200
Prórroga en el Cargo	C.D.A.	56	11/02/20	008440-002990-19	01/01/20	30/09/20			155110200
Extensión Horaria Docente	Comisión Directiva	43	12/07/19	008150-000340-19	01/07/19	22/12/19	20-26		155110200

	Expediente Nro. 008440-000023-24 **Actuación 7**	Oficina: DIVISION CONTADURIA OFICINAS CENTRALES - DIRECCION Fecha Recibido: 19/07/2024 Estado: Cursado

TEXTO

La División Contaduría Central informa que:

1) Existe disponibilidad presupuestal a nivel global en el ISEF.

2) El cargo Nº556184, Esc. G, Gº2, 20 horas, interino, (vto. 31/12/24), con extensión de 20 a 30 horas (vto. 31/12/24), del docente Stefano Benitez, se financia con recursos presupuestales del ISEF, Fin. 1.1, prog. 347.

Llave Presupuestal 155110100

Pase a Comisión Directiva ISEF

Firmado electrónicamentemente por Walter Antonio Da Luz Varela el 23/07/2024 14:29:32.
Firmado electrónicamentemente por Director de División - Contaduría Oficinas Centrales Cr. Bolivar Gustavo Morales Del Valle el 24/07/2024 14:04:16.

	Expediente Nro. 008440-000023-24 **Actuación 8**	Oficina: SECCIÓN SECRETARÍA COMISIÓN DIRECTIVA - CENTRO MONTEVIDEO - ISEF Fecha Recibido: 24/07/2024 Estado: Para Actuar

TEXTO