Original article

Acute effect of an Intra-Set Variable Resistance of back squats over 30-m sprint times of female sprinters

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Summary

Introduction: Several pre-conditioning methods have been tested in order to produce Postactivation Potentiation (PAP) in men. However, it is unknown if Intra-Set Variable Resistance generates the same effect in female sprinters.
Objective: Thus, the acute effect of an Intra-Set Variable Resistance (I-SVR) protocol of back squats on 30-m sprint times of female sprinters was determined.
Material and method: Ten female sprinters were the subjects of this study (age = 20.3 ± 1.9 years, body mass 56.0 ± 6.9 kg, height = 1.64 ± 6.1 m, 30-m sprint = 4609.2 ± 236.4 ms). The pre-conditioning with I-SVR consisted of 4 back squats exercise sets: each set included 22% 1RM X 5 reps (equivalent to 1.0-1.1 m•s^{-1}), 60% 1RM X 4 reps (equivalent to 0.6-0.7 m•s^{-1}), and 30-m sprint X 3 with a 2-minute rest.
Results: The repeated measures ANOVA did not show significant differences in 30-m sprint after the application of pre-conditioning protocols with I-SVR (p > 0.05), while [La] provided evidence of a significant increase post-effort (p < 0.0001). However, great individual variations were observed.
Conclusions: Considering that the pre-conditioning with I-SVR did not increase the performance in women sprinters, which may be due to insufficient load to elicit a PAP response or that the fatigue induced outweighs the benefit, the coaches considering the use of this pre-conditioning protocol in order to generate PAP must explore its effectiveness individually. Factors such as strength levels, protocol resistance used to generate PAP, and, above all, the recovery interval between pre-conditioning and the following sprint need further research.

Key words:
Postactivation potentiation. Back squats. Sprinter women.

Efecto agudo de un protocolo de resistencia variable intra-serie en sentadillas sobre el tiempo en 30 metros lisos en mujeres velocistas

Resumen

Introducción: Varios métodos de pre-activación se han probado para desencadenar Potenciación Post Activación (PAP) en hombres. Sin embargo, se desconoce si la Resistencia Variable Intra-Serie genera el mismo efecto en mujeres velocistas.
Objetivo: Determinar el efecto agudo de un protocolo de Resistencia Variable Intra-Serie (RVI-S) en sentadillas sobre el tiempo en 30 metros lisos en mujeres velocistas.
Material y método: Diez velocistas de nivel regional fueron parte de este estudio (edad = 20,3 ± 1,9 años, masa corporal 56,0 ± 6,9 kg, estatura = 1,64 ± 6,1 m, 30 metros lisos = 4609,2 ± 236,4 ms). La pre-activación con RVI-S consistió en 4 series de sentadillas: cada serie incluyó 5 repeticiones al 22% de 1RM (equivalente a 1,0-1,1 m•s^{-1}) + 4 repeticiones al 60% de 1RM (equivalente a 0,6-0,7 m•s^{-1}) + 3 carreras de 30 metros separadas con una pausa de 2 minutos. Las variables fueron: el tiempo promedio de tres repeticiones de 30 metros de carrera y concentraciones de Lactacto ([La]).
Resultados: La ANOVA de medias repetidas no mostró diferencias significativas en el tiempo promedio realizado en 30 metros lisos después de la aplicación de protocolos de pre-activación con RVI-S (p > 0,05), mientras que las [La] mostraron incrementos significativos post esfuerzo (p < 0,0001). Sin embargo, se observaron grandes variaciones individuales.
Conclusiones: Considerando que la pre-activación con RVI-S no mostró incrementos en el rendimiento en mujeres velocistas, posiblemente por una carga insuficiente para desencadenar PAP o que la fatiga muscular superó el posible beneficio, los entrenadores que consideren el uso de este protocolo de pre-activación para genera PAP deben explorar la efectividad en forma individual. Factores tales como los niveles de fuerza, la resistencia del protocolo usado para generar PAP, y por sobre todo el intervalo de recuperación entre la pre-activación y la subsiguiente carrera necesitan de mayor investigación.

Palabras clave:
Potenciación post activación. Sentadillas. Mujeres velocistas.

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Introduction

In recent years, the topic of strength training has led to the development of varied and innovative training methodologies[1-3]. One of the methodologies used to naturally enhance acute muscular strength is Postactivation Potentiation (PAP)[4-6]. Several pre-conditioning training methods have been applied in order to generate PAP, such as ballistic exercises, maximum isometric exercises, and squats, among others[7-9]. Some research has shown that, with the correct conditioning load and the appropriate rest, the subject will enhance the strength level temporarily[5,6,10]. Currently, pre-conditioning with Variable Resistance (VR) has taken a key role in the PAP[3,11]. A review performed by Soria-Gila *et al.*[3] concluded that pre-conditioning with Intra-Set Variable Resistance (I-SVR) with elastic bands and/or chains generated a significant increase in strength levels. Meanwhile, Turner *et al.*[2] concluded that pre-conditioning with plyometric exercises improved acceleration in 20-m sprints. In the same way, Vanderka *et al.*[1] showed evidence that a pre-conditioning with half-squats produces PAP in athletes and soccer players.

In the description of the PAP phenomenon, it has been observed that subjects who have great power are more likely to potentiate[8,12]. More specifically, it has been shown that I-SVR load evidenced a positive acute effect over time in 30-m sprints in elite male military athletes[13]; furthermore, an increase in the performance of 10-yard distance was observed after applying a pre-conditioning with I-SVR through a back squats exercise at 85% 1RM + 30% of additional load with an elastic band in recreationally resistance-trained males[12]. Fukutani *et al.*[14] also showed a significant increase in CMJ post I-SVR pre-conditioning (heavy condition: 1 x 45 – 1 x 60 – 3 x 75 – 3 x 90% at 1RM in squats; moderate condition: 1 x 45 – 1 x 60 – 3 x 75% at 1RM in squats). However, despite the existing evidence, it is still uncertain whether these pre-conditioning loads can generate the same effect in other types of population, let alone in the female population. Specifically, evidence has shown that loads above 80% at 1RM in subjects with low strength level could be detrimental, generate fatigue, and decrease athletic performance[15,16].

Despite the fact that scientific evidence has shown that pre-conditioning stimuli can generate PAP[8,9], not all methods applied generate the same effect; specifically, if the strength levels, the rest interval time, and other variables such as training volume and intensity, are not sufficient to establish a dosage-response connection[17,18]. In a systemic review performed by Huerta *et al.*[11], the effects from using different methods of VR as pre-conditioning to generate PAP were analyzed. The researchers concluded that there was not enough evidence to truly know the real effect of VR over PAP. However, there are indications that I-SVR can generate acute changes in the explosive strength levels[11]. Unfortunately, evidence shows that subjects with low power levels have fewer chances to potentiate, in these population the fatigue induced can outweighs the possible benefit (PAP)[8,16]. In addition, the effect of sex (gender) over PAP is not completely described[9]. Therefore, a plausible line of research is to check whether pre-conditioning through I-SVR applied in elite male military athletes[13] can produce the same effect in sprinter women.

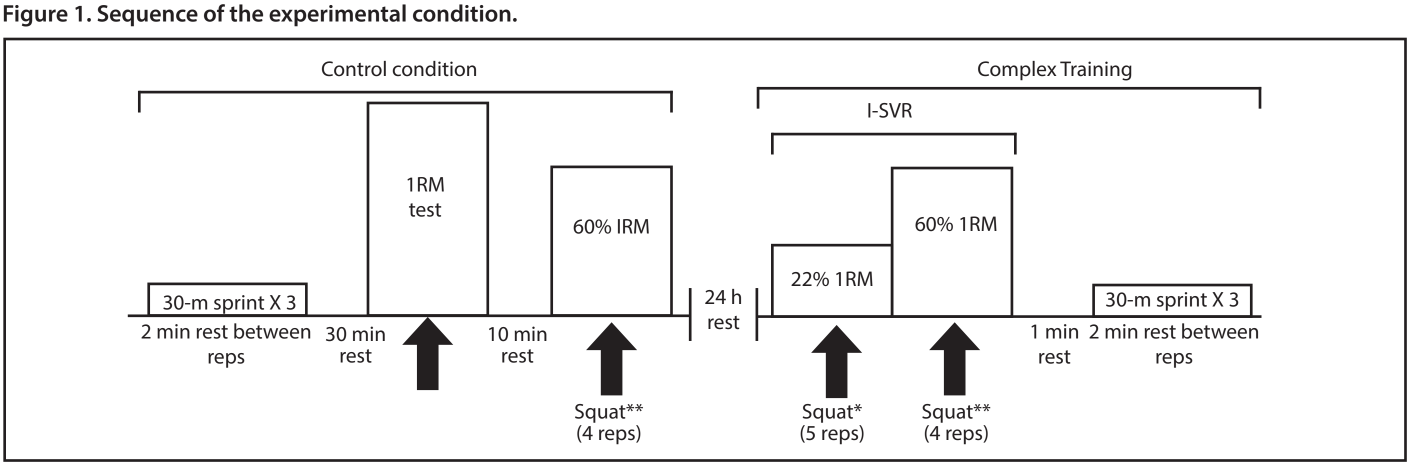
In connection to the above, it was the aim of this study to determine the acute effect of an I-SVR protocol in back squats over time in 30-m sprints in sprinter women.

Material and method

Experimental approach to the study

This study used a repeated measures design. All subjects were part of a control condition and an experimental condition (Figure 1); a 24-hour rest interval was set between both conditions. Each back squats set of pre-conditioning was performed with I-SVR. This variation of loads within the sets consisted of 4 sets of back squats exercises, with a load and repetition of each set being 1.0-1.1 m•s^{-1} X 5 repetitions (reps), 0.6-0.7 m•s^{-1} X 4 reps. The load was adjusted for each subject according to 1 repetition maximum (1RM), and the subjects were asked to perform back squats at the highest possible speed. Once the load was adjusted, all subjects performed the pre-conditioning at the required speed[19]. After performing pre-conditioning with back squats, 3 reps of 30-m sprints were performed with a 2-minute rest between each, the rest time between sets being 2 minutes. The dependent variables were: time in 30-m sprint and post-effort Lactate concentrations [La]. Some inves-

Figure 1. Sequence of the experimental condition.



*Load needed to move the squat bar between 1.0-1.1 m•s^{-1} (1.0-1.1 m•s^{-1} velocity in back squats).
**Load needed to move the squat bar between 0.6-0.7 m•s^{-1} (0.6-0.7 m•s^{-1}velocity in back squats).

Table 1. Characteristics of the subjects.

Subject	Age (y)	Body mass (kg)	Height (m)	% body fat*	Squat 1RM (kg)	Squat /body mass	30-m sprint (ms)
a	19.1	51.3	1.65	14.1	78.3	1.53	4826.0
b	22.5	43.0	1.52	14.1	79.6	1.85	4459.0
c	19.9	53.5	1.63	14.1	82.5	1.54	4386.7
d	17.7	60.0	1.70	18.8	92.7	1.55	4308.3
e	20.1	58.3	1.66	18.8	90.7	1.56	4633.3
f	21.3	56.9	1.64	14.1	93.0	1.63	4845.0
g	21.8	48.3	1.52	14.1	101.5	2.10	5009.3
h	23.1	63.8	1.63	18.8	112.0	1.76	4366.0
i	17.4	60.9	1.67	19.5	117.4	1.93	4721.7
j	20.3	63.7	1.60	19.5	115.9	1.82	4536.3
Mean	20.3	56.0	1.62	16.6	96.4	1.73	4609.2
SD	1.9	6.9	6.1	2.6	14.7	0.2	236.4

1RM: 1 repetition maximum.
*Sum of four skinfolds[4].

tigations have used 30-m sprints to observe changes in performance due to the PAP phenomenon[2,13], while [La] were used to observe the anaerobic metabolism[20]. Before starting the procedure, weight, height, and skinfolds were measured in all subjects. Fat percentage was obtained through the summation of all four skinfolds[21].

Subjects

10 sprinter women participated in this study (age = 20.3 ± 1.9 years [SD], body mass 56.0 ± 6.9 kg, height = 1.64 ± 6.1 m) (Table 1). All women and coaches were informed about the objective of the research and about the possible risks of the procedure. The subjects signed a written consent containing all the information of the study before proceeding with the protocol. The written consent and the study were approved by the Bioethics Committee of the Universidad de Playa Ancha, Chile (registry number 006/2017).

Procedures

All evaluated subjects had a 48-hour rest before the control condition intervention. The subjects were asked to refrain from caffeine ingestion or any substance that could increase their metabolism during the assessment. Both control condition and experimental condition took place between 9 am and 11 am. The procedure began with a warm-up consisting of 10 minutes of slow jogging, 5 minutes of dynamic stretching of the lower limbs, and then 3 X 80-m accelerations. Control condition included three evaluations: a) The mean times of 3 X 30-m sprint with a 2-minute rest. The times were measured at the starting point, 10 m, 20 m, and 30 m. The mean performance of all 30-m sprint reps was used for the statistical analysis and was named Control Sets (CS). 10-m and 20-m sprint times were also used for the statistical analysis (CS). 10-m, 20-m, y 30-m sprint were evaluated using a Chrono Jump® photocell and Chrono Jump software version 1.4.6.0®[13,20]. b) After a 30-minute rest, the indirect 1RM in back squats was measured using a lineal encoder Chrono Jump® and Chrono Jump software version 1.4.6.0®[22]. c) After a 10-minute rest, 4 reps of back squats between 0.6-07 m•s^{-1} were evaluated. The load needed to move the bar in back squats between 0.6-07 m•s^{-1} was equivalent to 60% 1RM[19]. The average performance in these four back squats reps was used for the statistical analysis.

The experimental condition consisted of 4 I-SVR sets. Each set included back squat pre-conditioning with I-SVR: 22% 1RM X 5 reps (equivalent to 1.0-1.1 m•s^{-1}), 60% 1RM X 4 reps (equivalent to 0.6-0.7 m•s^{-1})[19], and the mean times of 30-m sprint X 3 with a 2-minute rest interval. At the end of each set, [La] post-effort was measured with an h/p/Cosmos Sirius®. Between each set there was a rest interval of 2 minutes. Mean times of three reps per sets in 10-m, 20-m, and 30-m sprints were the dependent variables. These time points were used in the statistical analysis in order to compare the postactivation performance to control condition.

Statistical procedures

All statistical analyses were performed using the *Entorno de Programación R* software[23]. The mean of 10-m, 20-m, 30 m, [La], and velocity in back squats were submitted to the Shapiro-Wilk test. An analysis of the variance of repeated measures (ANOVA) was used to examine the effect of pre-conditioning with I-SVR on the mean times of 10-m, 20-m, and 30-m sprint performance, [La], and velocity in back squats. The ANOVA was used with five time points: a) control session (control set [SC]) before pre-conditioning with I-SVR, b) experimental set 1 (S1), c) experimental set 2 (S2), d) experimental set 3 (S3), and e) experimental set 4 (S4).

Individual responses on the mean times of 30-m sprint performance were analyzed using means, DS, and delta between different conditions. The size of the effect (SE) for both cases was calculated using partial Eta-squared.

The Bonferroni correction was used as post hoc analysis when the level of significance showed important differences among the means ($p \leq 0.05$). The size of the effect for the pairwise comparison was calculated using Cohen's d-test with the following effect scale: insignificant ($d < 0.2$), small ($d = 0.2 - 0.6$), moderate ($d = 0. - 1.2$), large ($d = 1.2 - 2.0$), and very large ($d > 2.0$). The level of statistical significance for all analyses was set at $p \leq 0.05$.

Table 2. Variation of mean performance after the application of a pre-conditioning with I-SVR of back squats.

Variables	control set mean ± SD	set 1 mean ± SD	set 2 mean ± SD	set 3 mean ± SD	set 4 mean ± SD	ANOVA *p*	Square ETA Partial
10-m sprint (ms)	1880.7±68.2	1872.8±63.1	1864.6±64.9	1868.2±54.7	1860.3±50.9	ns	0.029
20-m sprint (ms)	3262.8±149.9	3247.6±145.3	3254.5±144.2	3262.3±141.9	3245.7±121.1	ns	0.005
30-m sprint (ms)	4609.2±236.4	4580.1±234.9	4615.8±224.9	4603.2±231.2	4592.4±194.6	ns	0.005
[La] (mmol/L)	1.52±0.2	5.79±1.5	8.14±1.9	9.38±2.3	8.41±2.1	*	0.878
Squat velocity ($m \cdot s^{-1}$)	0.689±0.03	0.692±0.07	0.675±0.06	0.678±0.04	0.692±0.09	ns	0.033

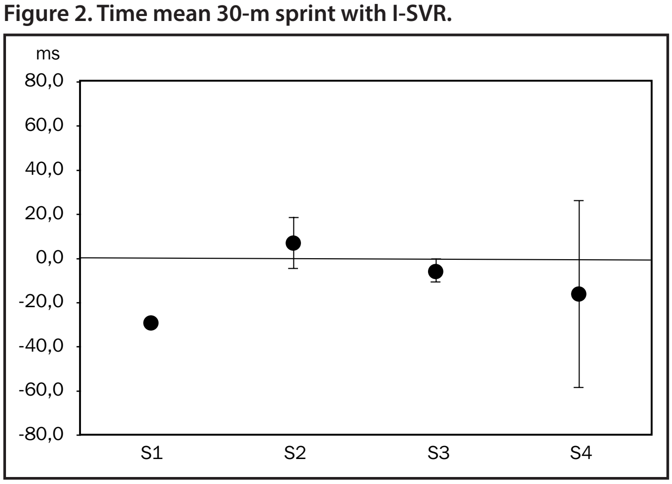
ms: (millisecond); SD: (standard deviation); * $p<0.0001$; ns (no significant).

Table 3. Individual performance mean variation post application of pre-conditioning with I-SVR of Back Squats.

Subjects	t-mean 30-m CS (ms)	t-mean t 30-m S1 (ms)	Δ S1-CS (ms)	% S1 vs CS	t-mean t 30-m S2 (ms)	Δ S2-CS (ms)	% S2 vs CS	t-mean t 30-m S3 (ms)	Δ S3-CS (ms)	% S3 vs CS	t-mean t 30-m S4 (ms)	Δ S4-CS (ms)	% S4 vs CS
a	4826.0	4549.3	-276.7	5.7	4543.3	-282.7	5.9	4569.3	-256.7	5.3	4726.7	-99.3	2.1
b	4459.0	4504.0	45.0	-1.0	4957.3	498.3	-11.2	4968.7	509.7	-11.4	4589.0	130.0	-2.9
c	4386.7	4790.7	404.0	-9.2	4639.7	253.0	-5.8	4619.7	233.0	-5.3	4749.3	362.7	-8.3
d	4308.3	4985.3	677.0	-15.7	4827.3	519.0	-12.0	4984.0	675.7	-15.7	4833.0	524.7	-12.2
e	4633.3	4493.3	-140.0	3.0	4594.3	-39.0	0.8	4562.0	-71.3	1.5	4751.3	118.0	-2.5
f	4845.0	4163.0	-682.0	14.1	4159.7	-685.3	14.1	4338.0	-507.0	10.5	4190.7	-654.3	13.5
g	5009.3	4534.3	-475.0	9.5	4647.7	-361.7	7.2	4430.7	-578.7	11.6	4408.7	-600.7	12.0
h	4366.0	4347.3	-18.7	0.4	4373.3	7.3	-0.2	4339.7	-26.3	0.6	4539.3	173.3	-4.0
i	4721.7	4661.3	-60.3	1.3	4671.0	-50.7	1.1	4487.7	-234.0	5.0	4657.0	-64.7	1.4
j	4536.3	4772.3	236.0	-5.2	4744.7	208.3	-4.6	4732.0	195.7	-4.3	4479.0	-57.3	1.3

I-SVR (intra-set variable resistance); t-mean 30-m (time mean in 30-m sprint); CS (control set); S1 (set 1); S2 (set 2); S3 (set 3); S4 (set 4); ms (milliseconds); Δ S_n-CS (delta time between experimental and control set); % S_n *vs* CS (percentage variation between experimental and control set).

Figure 2. Time mean 30-m sprint with I-SVR.



Results

Time in 10-m, 20-m, and 30-m sprint

Means and SD values are depicted in Table 2. ANOVA showed no significant differences for time in 10-m sprint ($F = 0.26$, $p = 0.89$, $ES = 0.029$), 20-m sprint ($F = 0.04$, $p = 0.99$, $ES = 0.005$), and 30-m sprint ($F = 0.04$, $p = 0.99$, $ES = 0.005$) (Figure 2).

Individual responses

The analysis showed that five out of 10 subjects (50%) increase in the mean performance of 30-m sprint throughout the experimental conditions, while seven out of 10 subjects (70%) showed an increase in their mean performance in one or more experimental sets in 30-m sprint time (Table 3).

Lactate

ANOVA showed significant differences in [La] post-effort ($F = 64.49$, $p < 0.0001$, $ES = 0.878$) (Table 2), while the post hoc analysis showed evidence of significant differences in all the pairs analyzed (Table 4).

Back squats speed

ANOVA did not provide significant differences for the time in back squats execution speed ($F = 0.30$, $p = 0.87$, $ES = 0.033$) (Table 2).

Discussion

Taking into consideration that the effects of sex (gender) and I-SVR over PAP were not completely outlined[9,24], the acute effect of a pre-conditioning protocol with I-SVR in back squats over time in 30-m sprints in high-level sprinter women had to be determined. The pre-conditioning

Table 4. Post hoc analysis for [La] among the control set and 4 experimental sets.

Contrast	mean ± SD	mean ± SD	Δ	Confidence Interval	Student's t-test	ES
Pair 1 [La] mmol/L^{-1}	Control Set 1.52±0.2	Set 1 5.79±1.5	4.27 mmol/L^{-1}	3.12 - 5.41 mmol/L^{-1}	*	4.89
Pair 2 [La] mmol/L^{-1}	Control Set 1.52±0.2	Set 2 8.14±1.9	6.62 mmol/L^{-1}	5.15 - 8.08 mmol/L^{-1}	*	6.07
Pair 3 [La] mmol/L^{-1}	Control Set 1.52±0.2	Set 3 9.38±2.3	7.96 mmol/L^{-1}	6.13 - 9.58 mmol/L^{-1}	*	6.21
Pair 4 [La] mmol/L^{-1}	Control Set 1.52±0.2	Set 4 8.41±2.1	6.89 mmol/L^{-1}	5.35 - 8.42 mmol/L^{-1}	*	5.87

[La] (Lactate concentrations); SD (standard deviation); ES (effect size); * $p<0.0001$.

with I-SVR of 4 back squats exercise sets (30% 1RM X 5 reps + 60% 1RM X 4 reps) showed a significant increase in 30-m sprints performed by elite male military athletes[13]. In connection with the main aim of this study, ANOVA results did not show a significant difference among the Control Set and the four Experimental Sets ($p > 0.05$). Unfortunately, the references found with I-SRV were scarce[3,11,13], even less in women. However, the main premise in which the research was based was that pre-conditioning with VR generated a significant increase in acute muscular strength levels[3], and that increment was evidenced in the research carried out by Wyland *et al*[12]. The researchers presented evidence of a significant decrease in 10-yard times after performing squats at 85% 1RM + 30% additional load with an elastic band ($p = 0.002$)[12]. Another relevant precedent for this study was that the strongest subjects can generate PAP[14,16]. A study performed by Fukutani *et al.*[14] also showed evidence of such a phenomenon. In the study by Fukutani *et al.*[14], the sample used included weightlifters who were capable of lifting 2.4 times their own body weight in squats. After the I-SVR conditioning (heavy condition: 1 x 45 – 1 x 60 – 3 x 75 – 3 x 90% 1RM in squat exercises; moderate condition: 1 x 45 – 1 x 60 – 3 x 75% 1RM in squat exercises), PAP was observed in both conditions ($p < 0.05$). Equally, Hirayama *et al.*[25] reported PAP in CMJ after the application of protocols with I-SVR ($p < 0.05$). Meanwhile, Seitz *et al.*[8] determined that the size of the effect (SE) in speed tests was moderate after a pre-conditioning of the lower limbs (SE = 0.51). In more detail, at the end of this last study the researchers observed: a) a greater PAP effect among stronger individuals, unfortunately, in this study there was no connection between PAP and strength levels in back squats performed by sprinter women; b) a greater PAP effect with polymeric loads (SE = 0.47) when compared to other pre-conditioning methods such as high-intensity loads (SE = 0.41), traditional moderate intensity (ES = 0.19), and maximum isometric (ES = -0.09); c) that weaker subjects respond better to longer rest intervals; and d) that both weaker and stronger subjects evidence a greater PAP after conditionings with shallower squats[8]. In this regard, after an conditioning with I-SVR in a power zone ranging from 0.6 and 0.9 m•s^{-1} of vertical bar speed[19], Huerta *et al.*[13] reported a significant enhancement in 30-m sprints among the CS and the four experimental sets ($p < 0.001$). However, Huerta *et al.*[13] found that elite male military athletes are more likely to generate PAP due to the level of potentiation is dependent on the individual's level of strength and resistance training experience[8].

Considering that 50% of the sample enhanced their performance in 30-m sprints and that 70% showed improvements in one of the experimental sets, the authors believe that the methodology used[13] is applicable to female sprinters. However, if I-SVR pre-conditioning has to be implemented, individual responses should be checked, and it is advisable to use a longer rest between pre-conditioning and the following exercise[8]. This is due to the fact that the enhancement scope of the sprint might be affected by the rest interval among each set[7]. Moreover, the volume, type, and intensity of the conditioning stimulus have an impact on the connection between PAP and fatigue[26]. In research developed by Boullosa *et al.*[27] a CMJ in PAP was observed after a 9-minute rest. Unfortunately, the authors used a sample comprised of resistance-trained men (squat/body mass = 2.4), and that same research also concluded that the best method to induce PAP is independent from the rest between pre-conditioning and the following exercise[27]. Similarly Lim *et al.*[28] concluded that the pre-conditioning with single-joint isometric, multi-joint isometric, and multi-joint dynamic generates large individual variations; more specifically, when applying similar loads some athletes potentiate and others do not. Lim *et al.*[28] suggest that coaches should explore the effectiveness of different PAP protocols individually.

In connection to the secondary aim of this study – to determine the variations in general and local fatigue indicators during the application of an acute I-SVR protocol in back squats in female sprinters[20] – the results of ANOVA showed a significant difference among the CS and the four experimental sets in which [La] ($p < 0.0001$) but no significant difference in the execution of back squat exercises ($p > 0.05$). Similar to this research, a study performed by Huerta *et al.*[13] reported no significant changes in the maximum and average power in back squat exercises. The foregoing is understood as a non-existing occurrence of local fatigue in both sprinter groups after applying I-SVR pre-conditioning protocols. However, when comparing both results of the researches, there is a noticeable difference in [La] post-effort. While the men athlete group showed no significant changes in [La] post-effort after the application of a I-SVR protocol[20], women athletes showed a significant increase in [La] using the same I-SVR pre-conditioning loads as the men and 30-m sprint repetitions from the first to the fourth experimental sets. This allowed the authors to infer that these pre-conditioning loads with I-SVR generate different effects in groups with different training level[16]. While there was an increase in the performance of 30-m sprint in men[13], the average in women did not generate PAP. Perhaps, an increment in the rest period between each 30-m sprint repetition and among the experimental sets might trigger a PAP response in this group[8,16]. In a research carried out by West *et al.*[29], where performance was evaluated through CMJ, significant decreases were reported after the application of a backward sled dog protocol of 5 sets of 2 X 20-m loaded with 75% body mass ($p < 0.001$). An important precedent present in that research is that [La] increased significantly the moment the protocol application ended

($p < 0.001$). Also, it is important to notice that the load applied by West *et al.*[29] was heavier than the one applied in this research. However, the pattern of [La] is seen as a fatigue indicator in all the studies mentioned here, and for that matter it is also a parameter that must be considered in all protocols to generate PAP.

Conclusions

This study showed no evidence of enhancement in the time of the test performance (10-m, 20-m, and 30-m sprints) after the application of pre-conditioning protocols with PAP I-SVR. However, large individual variations were observed post I-SVR pre-conditioning. Therefore, a pre-conditioning with I-SVR in back squats exercise: 22% 1RM X 5 reps (equivalent to 1.0-1.1 $m{\bullet}s^{-1}$), 60% 1RM X 4 reps (equivalent to 0.6-0.7 $m{\bullet}s^{-1}$)[18], 30-m sprint X 3 with a 2-minute rest, does not generate PAP in all female sprinters. Considering that the pre-conditioning with I-SVR did not increase the performance in women sprinters, which may be due to insufficient load to elicit a PAP response or that the fatigue induced outweighs the benefit, the coaches considering the use of this pre-conditioning protocol in order to generate PAP must explore its effectiveness individually. Factors such as strength levels, protocol resistance used to generate PAP, and, above all, the recovery interval between pre-conditioning and the following sprint need further research.

Conflict of interest

The authors do not declare a conflict of interest.

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