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THE POST-ACTIVATION EFFECT OF COMBINED RESISTED AND ASSISTED SPRINTS

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ABSTRACT

Resisted and assisted training methods aim to increase neural activation, or post-activation potentiation (PAP), to enhance sprint performance. A preloaded stimulus causes a temporary performance increase that is more significant than what warm-up alone can provide. Resistance activities have traditionally been used to induce post-activation potentiation. Little is known when assisted and resisted sprints are combined and their effect on PAP. Therefore, this study aimed to examine the acute potentiating effect of combined resisted and assisted sprints on subsequent 20 m sprint performance. Sixteen physically active young males performed a baseline 20 m sprint followed by four assisted 20 m and four 20 m resisted sprints using a bungee cord. After the assisted-resisted stimulus, the participants performed one 20 m sprint at 4, 6, and 8 minutes. There was no significant improvement in 5, 10, or 20-m sprint times following the assisted-resisted stimulus. Therefore, the additive effect of assisted-resisted sprints failed to induce post-activation potential. The additive effect of assisted-resisted sprints could not induce post-activation potential to enhance subsequence sprint performance.

Keywords: *Post-activation potential, sprinting, elastic tubing*

INTRODUCTION

Repeated short sprints are crucial in team field sports like rugby, football, and hockey, playing a vital role in both offensive and defensive moments (Upton, 2011). Acknowledging their significance while developing training programs is essential, as the ability to execute them with high intensity and frequency is a key determinant of success in these sports. Two standard training methods to enhance sprint performance are resisted and assisted training. The primary objective of these methods is to increase neural activation, known as post-activation potentiation (Upton, 2011). Due to its contractile history, post-activation potentiation (PAP) is an acute and temporary muscle performance enhancement. A preloaded stimulus causes a temporary enhancement in performance that surpasses the benefits of warm-up alone. (Turner et al., 2015). Therefore, the previous contraction history of a muscle has a significant impact on the subsequent mechanical performance of the muscle. PAP has traditionally used resistance activities that have been shown to have longitudinal positive effects on sprint performance (Tillaar & Heimburg, 2017). However, while training for PAP, performance enhancement with a small 'window of opportunity' and insufficient rest post-stimulus may reduce performance due to residual fatigue from the stimulus exercise (e.g., heavy back squats). In contrast, excessive rest may dissipate potentiation, resulting in slight performance improvement (Tillin & Bishop, 2009).

A common form of resistance training to induce PAP has been heavy squats (HS), with reported findings showing that performing 10 single repetitions of HS with a weight equivalent to 90% of one-repetition maximum (RM) resulted in an improvement in specific running phases between 0-10 m in amateur basketball players within 5 minutes of the stimulus (Comyns et al., 2010). Another study found that 3RM back squats had significant gains among rugby players in running velocity at 20 m and 30 m (Comyns et al., 2010). Weighted sled pulls have also been identified as a viable PAP training method, with research reporting that a sled loaded to 75% body mass, with adequate rest (8-12 minutes), is an effective preload stimulus for enhancing sprint performance (Winwood et al., 2016). Conversely, Whelan et al. (2014) reported that weighted sled pulls <30% body mass is insufficient to elicit a fatigue effect or PAP response. It is suggested that weighted sled towing may assist athletes in producing larger horizontal or impact ground reaction forces to increase acceleration performance (Kawamori et al., 2014). Previous research has employed an isotonic resistance training load of 75-95% 1RM, or 75% of body mass, which has been successful in eliciting a PAP response in sprint performance (Winwood et al., 2016). Recently, elite female sprinters showed that a 20 m resisted sprint of 10% of body weight using an electronically controlled resistance device improved 20 m flying start (Matusiński et al., 2021).

Assisted sprint training has increased unassisted stride frequency and improved velocity with standard methods, including high-speed towing and downhill sprinting (Paradisis & Cooke, 2006). Studies examining downhill running effects found that a slope of 5.8° produced a 6.4% improvement in 10-yard and 7.1% improvement in 40-yard sprints compared to flatland running (Upton, 2011). Assisted towing has been reported to increase stride length at 40-50 N while maintaining stride frequency during towing (Clark et al., 2009). A study using an electronically controlled assistance device in basketballers revealed that a 5% body-mass assisted slide step reduced the time to complete two sets of 5m slide step movements by 4.6% (Gepfert et al., 2020).

The primary objective of this study was to explore the acute effect of incorporating two different forms of bungee cord sprint training, specifically bungee-resisted and bungee-assisted, on sprint performance among young male participants. While previous research has shown that each method alone can have positive outcomes, there is scant evidence on the combined effects of resisted and assisted sprint within a single session. It was hypothesized that combining assisted and resisted sprints would improve sprint performance.

METHODOLOGY

Participants

Sixteen physically active males (16 $\pm$ 0.68 years old; height 1.72 $\pm$ 0.39 m; weight 62.3 $\pm$ 5.33 kg) who were involved in team sports of soccer ($n=6$), field hockey ($n=4$), rugby ($n=6$) volunteered to participate in the study. Participants were engaged in two weekly practices and a game on the weekend with their respective teams. All participants were injury-free and had completed a pre-exercise questionnaire and informed consent signed by legal guardians. Before the session, all refrained from high-intensity physical activity 24 hours before testing.

Procedure

Before testing commenced, participants attended a familiarisation session on the equipment and testing. This was completed indoors on a sprung-wooden surface, and timing was measured using beamed timing gates (SmartSpeed, Fusion Sport, Queensland, Australia) located 0.5 m above the ground, which recorded times on a wireless touch-screen device.

Warm-up

All participants performed a standard warm-up consisting of a 200 m jog at 40-60% of perceived maximal effort. The participants were instructed that it should feel light to moderate intensity, where conversation is possible. This was followed by ten walking lunges. Participants were instructed to step forward, lowering their back knee towards the ground, keeping the front knee over the ankle, and then pushing back up to the starting position. Ten alternating sumo squats were performed. Participants were instructed to position their feet in a wide stance (greater than shoulder width) and squat down with thighs parallel to the ground while keeping their knees aligned with their toes. On standing up, participants pivoted on one foot to face the other way and lowered into a squat. The sequence was then repeated. Following the sumo squats, 10 dynamic frontal and lateral leg swings are performed on each leg. Participants stood on one leg, swinging the other leg forward and backward (frontal) and then side to side (lateral) in a controlled manner. Participants finished with six 20 m stride outs performed at 50% of their perceived maximal effort with 2-3 minutes rest between each repetition.

Baseline test

Following the warm-up, participants performed a single maximum-effort 20-m sprint through the timing gates. In a standing split stance starting position, participants stood on a marked line 0.5 m behind the first timing gate. Participants were informed to run past the last 20 m gate and not to decelerate prior to the final gate.

Bungee Towing Stimulus

After a 2-minute rest after the baseline test, participants were matched according to their baseline sprint scores and organized into pairs. Participants were tethered together by a waist harness and a 6 m flex cord bungee encased in a material safety sleeve (Catapult cord, Hart Sport, Auckland, New Zealand). The resisted participant took three steps forward to create elastic potential energy in the bungee before commencing the sprint. At 2 minutes rest, both participants simultaneously perform a maximum effort sprint, covering 20 m assisted before slowing to a stop. Once stopped, the participants had a minute rest, during which they would switch roles and perform the same starting procedure as before, with a minute rest between each participant. This was repeated 8 times so that each participant performed 4 resisted and 4 assisted sprints.

Post-test

Four minutes after the last bungee tow, the participants performed the first unassisted 20-timing gated sprint and again at 6 and 8 minutes. Rest times were determined from previous PAP studies that identified a potentiation in this period of 8 minutes (Comyns et al., 2010; Seitz & Haff, 2016; Winwood et al., 2016).

Statistical Analyses

To determine main and interaction effects, a two-way (distance [5 m, 10 m, 20 m] x time [baseline, post-4 min, 6 min, 8 min) analysis of variance (ANOVA) was performed. Post-hoc comparisons were performed using the Bonferroni correction when a significant F-value was achieved. The level of significance was set at $p \leq .05$. Statistical analysis was performed using Statistical Package for Social Sciences (SPSS, Statistics version 28, IBM New York, USA), and the values are presented as mean ± standard deviation (*SD*).

RESULTS

The main effect of time on sprint scores was not statistically significant ($p = .378$, Table 1), indicating no notable changes in sprint performance over time. Similarly, the interaction effect of distance x time was not significant ($p = .178$), indicating no significant differences in 5 m, 10 m, and 20 m sprint scores between baseline and post-assisted-resisted stimulus at 4, 6, and 8 minutes (Table 2). This suggests that the sprint performance at each distance was maintained across the different time points. The non-significant p-values ($p > .05$) for both the main effect of time and the interaction effect of distance x time indicate that the assisted-resisted stimulus did not elicit any significant changes in sprint performance over the 8-minute period.

Table 1. *Mean ± SD, the main effect of time on sprint scores (sec)*

Time	Sprint score
Baseline	1.98 ± 0.87
post-4 min	1.97 ± 0.86
post-6 min	2.00 ± 0.87
post-8 min	1.99 ± 0.89

Table 2. *Mean ± SD, 5 m. 10 m and 20 m sprint scores (sec) at baseline, post 4, 6, and 8 minutes*

Distance	Time			
	Baseline	post-4 min	post-6 min	post-8 min
5 m	0.99 ± 0.06	0.99 ± 0.02	1.02 ± 0.06	0.98 ± 0.02
10 m	1.89 ± 0.09	1.88 ± 0.09	1.90 ± 0.06	1.90 ± 0.07
20 m	3.05 ± 0.12	3.03 ± 0.10	3.08 ± 0.11	3.09 ± 0.12

DISCUSSION

Currently, scant data is available to assess the effects of a combined assisted-resisted sprint session in eliciting a PAP. This study aimed to determine whether assisted-resisted bungee stimulus would evoke a potentiating effect and enhance 20 m sprint performance. From previous studies, it was hypothesized that rest times of 4, 6, and 8 minutes after the stimulus would be most conducive to observing any potential impact on sprint times (Comyns et al., 2010; Seitz & Haff, 2016; Winwood et al., 2016)The results revealed no significant gains in subsequent sprint performance from the assisted-resisted sprints at 4, 6, and 8 minutes post-stimulus.

In support of the current findings, Kotuła et al. (2023) reported no significant difference in the 30 m sprint times between baseline and post-7 minutes for combined assisted-resisted and assisted-only sprints. However, the authors revealed that 30 m sprint time performance improved post-7 minutes for resisted-only sprints. Similarly, Matusiński et al. (2021) found that in female sprinters, a single resisted sprint of 20 m using an electronically controlled resistance device improved 20 m flying sprint at post-5 minutes. This supports previous research that resisted-only sprint activities improved acute sprint performance (van den Tillaar & von Heimburg, 2017; Winwood et al., 2016; Wong et al., 2017).

Compared to a bungee cord, a sled or an electronically controlled resistance device can provide a constant load through the entire sprint distance, which has been reported to influence subsequent performance. In sled towing, Wong et al. (2017) reported that 30% of body mass acutely enhanced 5 m sprint time by 4.4%. Similarly, Matusiński et al. (2021) found that a 10% body mass load elicited by an electronically controlled device improved 20m flying start sprint performance, while heavier loads of 75% of body mass improved 20 m sprint performance by 1.8% (Seitz et al., 2017). Therefore, light-resisted loads may be more effective in the acceleration phase, while larger resisted loads may have a place in improving maximum velocity (Matusiński et al., 2021).

This study employed two distinct modes of sprints, namely stimulus-assisted and resisted. These two modes are diametrically opposite in their approach. Assisted sprinting focuses on stride frequency, which necessitates neuromuscular adaptations to enhance the efficiency of motor unit synchronization — in contrast, resisted sprinting attempts to activate more muscle fibers by increasing neural activation, improving stride length (Matusiński et al., 2022). However, using a bungee cord in assisted sprinting may have led to overstriding and braking, nullifying any possible effects of resisted sprinting in transferring to an acute improvement in subsequent sprint performance.

The recovery of 2 minutes employed in the all-out sprints may have elicited residual fatigue that, in turn, influenced the results. However, previous researchers have used a 2-minute rest between sprints (Seitz et al., 2017; Upton, 2011; Wyland et al., 2015). The lack of significant results in the current study on sprint performance could be attributed to residual fatigue, which involved four sets of assisted and four sets of resisted 20 m sprints. However, Kotuła et al. (2023) employed a similar total volume of 160 m (4 sets of 40 m) and did not produce improved subsequent sprint times at 20 m, 30 m, and 50 m in combined and assisted-only sprint conditions. For resisted-only sprints, however, improved 30 m sprint time. In contrast, previous research showed acute improvement in 20 m flying sprint time with a low-volume single 20 m resisted-only sprint using 10% of body mass (Matusiński et al., 2021). Similarly, the percentage changes in the sprint times during the post-intervals showed only minor improvement (0.5 to 1%) or decline (0.5 to 3%), which were not statistically significant. This confirms that the combined assisted-resisted sprint stimulus did not substantially impact sprint performance.

While this study focused on the acute effects of combined assisted-resisted sprint training, the longitudinal effects of such training methods remain an area for future research. It is important to note that understanding the long-term impact of training interventions is essential for developing comprehensive training programs. Previous research has indicated that longitudinal training interventions, such as resisted sprints, can lead to significant improvements in sprint performance over time. For example, Cahill (2020) reported that eight weeks of resisted sprint training improved 20 m sprint times in adolescent athletes. Therefore, the benefits of PAP from assisted sprinting over prolonged training periods could potentially enhance neuromuscular adaptations and sprint performance and are worthy of further investigation.

The optimal rest interval to maximize PAP and improve subsequent sprint performance following sprint-assisted or sprint-resisted stimulus can vary depending on factors such as individual athlete characteristics, training goals, and the intensity of the stimulus. Research suggests that a 5-minute post-conditioning activity recovery interval in well-trained participants significantly improves sprint performance (Seitz & Haff, 2016; van den Tillaar & von Heimburg, 2017). The resistance load depends on the bungee tubing and the participant's body mass during towing. In an ideal setting, it would have been good to match body masses between the pairs of participants to ensure the resistance load was comparable. However, sprint ability was deemed more important in matching participants with similar sprint abilities according to their baseline sprint scores. In future studies, both assistance and resistance load could be acquired by measuring resistance force via a force transducer attached to the bungy and determining the body masses of each matched pair. Given that the current cohort consisted of younger participants, a longer rest interval of 8-12 minutes may have provided an opportunity to explore a potentiating effect to maximize the impact of PAP on sprint performance. Recently, Kotuła et al. (2023) reported that after 48 hours of using low-volume combined resisted-assisted or assisted-only sprinting, 50 m sprint time improved in female sprinters. The participant's overall development may have impacted the outcome of this study. While the participants were engaged in team sports, their physical strength levels could have affected the results. Previous studies have indicated that the PAP effects are more pronounced in stronger athletes (Gołaś et al., 2016; Wilson et al., 2013).

In this study, combining the assisted sprinting stimulus with the resisted sprint stimulus failed to provide a combined effect in potentiating the subsequent sprint performance. When training a large group of athletes in a team setting, using a bungee for sprinting is more practical due to its convenience and portability. However, the magnitude of the assistance or resistance it provides is unknown. Therefore, measuring the tension in the bungee before conducting any tests to gauge the amount of resistance or assistance being applied to participants would be beneficial. Additionally, the bungee stretch may only provide a limited distance of assistance or resistance before losing effectiveness, which is likely dependent on the partner's body mass; this also needs further investigation.

Additionally, the recovery of 2 minutes employed in the all-out sprints may have elicited residual fatigue that, in turn, influenced the results. However, previous researchers have used a 2-minute rest between sprints (Wheelan et al., 2014; Upton, 2011; Seitz et al., 2017).

CONCLUSION

In this study, male youth participants reported no significant improvement in 5, 10, or 20-m sprint performance following the assisted-resisted sprint stimulus. Therefore, the additive effect of assisted-resisted sprints failed to induce post-activation potential to enhance subsequence sprint performance.

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