ORIGINAL ARTICLE

Loaded hip thrust-based PAP protocol effect on 20 meters sprint performance

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ABSTRACT

Background and Study Aim. This study aimed to investigate the effects of post-activation strengthening protocol (PAP) based on barbell hip thrust movements with different rest intervals on subsequent sprint performance. Material and Methods. Nine physical education and sports students (age 19.5 ± 0.2 years; height 180.3 ± 5.2 cm; body mass 81.2 ± 6.9 kg) participated in the study. 1RM of the barbell hip thrust movements of the athletes was taken and 85% of the movement was calculated (85 PAP). The athletes performed three different protocols after the dynamic warm up. The first protocol was 85PAP + 15 s rest interval, the second protocol consisted of 85PAP + 4 min rest interval; and the other protocol was 85PAP + 8 min. rest interval. Each protocol was followed by a 20-m sprint. Results. After the 85PAP protocol, there was a decrease in the sprint time after 15 s, 4 and 8 minutes ($p < .05$). Conclusions. When the waiting time increased, the sprint performance improved. This study demonstrated that intensive BHT exercise could increase the PAP effect. It was also found that the effect of the intensive BHT could vary according to the strength level of the individual.

Keywords: Performance analysis, Hip thrust, Strength, Pap, Neuromuscular abilities, Sprint.

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INTRODUCTION

Various forms of warm-up exist for practice, training, and competition activities of athletes. The traditional warm-up paradigm involves a brief period of low intensity aerobic-type activity, followed by static stretching and activity-specific movements (Schıllıng & Stone, 2000). The previous studies that supported these methods partly and as a whole concluded that they were equivocal, suggesting both positive and negative effects (Schıllıng and Stone, 2000). Since the physiological requirements of activities differ, the type of warm-up should also be specific to the requirements of the task. The overall intention of the warm-up should be to maximize performance acutely and reduce risk of injury in the given sport (Schıllıng and Stone, 2000; Guillich and Schmidtbleicher, 1996).

Heavy resistance training is a component in the long-term preparation of athletes for competition. The primary purpose of chronic heavy resistance training for athletes is typically to increase muscle force production, and subsequently velocity and power expression. Heavy resistance training, when performed in a maximally accelerative pattern, results in long-term improvement in measures of power and explosive force (Moss et al., 1997). Despite the research focusing on the long-term effects of heavy resistance training, the current understanding of the acute effects is less than comprehensive. On an acute level, it is clear that excessive volume and load may result in fatigue (Hakkınen, 1993). However, scenarios exist in which heavy weight training may enhance performance immediately afterwards (Hamada et al., 2000; Smith et al., 2001).

Post activation potentiation refers to a "*phenomenon whereby muscular performance is enhanced acutely after an activity executed at a relatively higher intensity*" (Lowery et al., 2012). Enhanced rate of force development and muscular power augment explosive muscle actions such as jumping (Kilduff et al., 2007; Kilduff et al., 2008). Suggested mechanisms for PAP are the phosphorylation of myosin regulatory light chains, subsequently increasing myofibrillar sensitivity to Ca2 + secretion from the sarcoplasmic reticulum, and increased recruitment of higher order motor units (Gullıch and Schmıdtbleıcher, 1996; Hamanda et al., 2003; Hodgson et al., 2005; Osteras et al., 2002). This acute enhancement of muscular power has been suggested as the premise upon which complex training is based (Ebben, 2002). Through this enhancement of muscular power, complex training is expected to produce superior chronic exercise adaptation in comparison to traditional strength and power training combinations (Ebben, 2002; Gullıch and Schmıdtbleıcher, 1996). Acute increases in performance can be substantially affected by the balance between PAP mechanisms and fatigue (Chatzopoulos et al., 2007; Jones and Lees, 2003). These "*opposing effects*" have usually produced inconsistent findings and unclear training guidelines (Lowery et al., 2012; Mola et al., 2014; Sale, 2002). Moreover, it appears that this balance may be altered by several factors, such as training experience, length of the rest period prior to subsequent exercise as well as the volume and intensity of conditioning activity (Wilson et al., 2013).

Accordingly, many studies have been designed to determine the optimal PAP strategy to induce positive short-term effects in trained subjects (Gourgoulis et al., 2003; Hanson et al., 2007; Jones and Lees, 2003; Young et al., 1998). In order the PAP to be effective, a recovery interval of 4 to 11 min is required (Seitz & Haff, 2016; Wilson et al., 2013; Kilduff et al., 2008). This could stem from the hypothetical relationship between PAP and fatigue (Tillin and Bishop, 2009). At the completion of the conditioning activity, both potentiation effects and fatigue are present, but closer to the conditioning activity, due to acute biochemical and mechanical alterations, muscular fatigue overcomes the potentiation effects leading to reduced performance (Benister et al., 1999). DelloIacono and Seitz (Dello and Seitz, 2018), recently proposed a novel approach to enhance PAP effects: by using the optimum power load (Loturco et al., 2015) in the conditioning activity, less fatigue should be accumulated, allowing for greater potentiation effects in the subsequent activities (Tillin and Bishop, 2009; Benister et al., 1999). This logic is based on the fact that optimum power loads are lighter compared to the relatively heavier loads (i.e., >85% 1RM) commonly used to elicit a PAP effect, and are thus expected to be less fatiguing while everything else is equal. It should be noted that optimum power could be defined as the mean propulsive power output calculated from the portion of area under the power-time curve, during which the acceleration of the upward motion is greater than gravity (i.e., a ≥ 9.81 m • s-2) (Loturco et al., 2015).

To test this hypothesis, DelloIacono and Seitz (Dello & Seitz, 2018) compared the effects of two PAP protocols on sprint performances of elite male handball players using either 85% of 1RM, or a load enabling optimum power development, with the exercise modality being the barbell hip thrust. Greater impairments in 5 m and 10 m sprint performances were observed following the 85% of 1RM protocol immediately after the conditioning activity, and greater improvements in 5 m, 10 m and 20 m sprint distances after 4 min and 8 min following the optimum power protocol.

METHOD

Study design

The sprints were measured using electronic timing gates positioned at the start line, 10 and 15 meters from the start line, and at 0.5 meters height from the ground. All athletes initiated the sprint, in their own time, from a semi-crouched position with the front foot 20cm from the start line. The athletes received verbal encouragement to sprint at maximal effort. Following the baseline assessment, the athletes performed experimental PAP protocol, and then were reassessed for a single 20m sprint with maximal effort at 15s, 4min, and 8min. The 20 m sprint performances performed in different protocols were recorded and analyzed.The participants performed either three sets of six repetitions of 85PAP, matched according to the calculation described above. These conditioning protocols were used since they were commonly included as part of weekly conditioning programs. The rest period between sets was 2min. This rest period was determined because the BHT was sufficient to prevent execution failure at the 85% PAP protocol stage. 85% PAP Protocol were performed at a self-chosen pace, with one researcher and one coach supervising all exercises and providing appropriate motivation.

Data collection

Nine male (age 19.5 ± 0.2 years; height 180.3 ± 5.2 cm; body mass 81.2 ± 6.9 kg) students from Kocaeli University Sports Faculty volunteered to participate in the study. The athletes had at least five years of practice as four days a week in different branches, which were jumping, sprint and resistance exercises. Written informed consent was obtained from the athletes after they received an oral explanation of the purpose, benefits, and potential risks of the study. All procedures were conducted in accordance with the Helsinki Declaration.

Research design

1RM of the barbell hip thrust movements of the athletes was taken and 85% of the movement was calculated (85 PAP). Athletes first performed a 15-min general warm-up consisting of various dynamic mobilization exercises for the lower body musculature. After the warmup, three different protocols were performed on same days (Fig. 1). The first protocol was 85PAP + 15 s rest interval, the second protocol consisted of 85PAP + 4 min rest interval; and the other protocol was 85PAP + 8 min. rest interval. Following each protocol, 20-meter sprint time was taken with photocell. It was used to compare the effects of 85% 1Rm (85PAP) PAP protocols on subsequent performance. First of all, BHT 1 RM values were calculated. Anthropometric measurements of body and body masses were made on the same day after one week, and sprint performances of 85% PAP were calculated. Accordingly, the BHT exercise was performed by having the upper back of the participant rest on a bench. Feet of the participants were slightly wider than shoulder-width apart, with the toes on the hips of the participant. The participants were instructed to thrust the barbell upwards while maintaining a neutral spine and pelvis. (Table 1).

Table 1. PAP Protocol Practice %85 PAP (BHT) + Sprint Protocol.

P1	Six repetition %85PAP (BHT) + 15 sec. Recovery duration 20 m. sprint
P2	Six repetition %85PAP (BHT) + 4 min. Recovery duration 20 m. sprint
P3	Six repetition %85PAP (BHT) + 8 min. Recovery duration 20 m. sprint

Between each protocol, the heart rates of the athletes were checked for recovery. The athletes with 110HR/Min were deemed ready for the next protocol

20-m Sprint Test

The sprints were measured using electronic timing gates (Photocell, 0.001 s accuracy, Bolzano, Italy) positioned at the start line and 20 m from the start line. All athletes initiated the sprint in their own time, from a semi-crouched position with the front foot 20 cm from the start line. After each BHT exercise, the athletes had a sprint performance of 20 m after different recovery durations (15 sec, 4 min, 8 min). The athletes received verbal encouragement to sprint at maximal effort.

Data analysis

The statistical analysis and descriptive statistics of the data obtained were made with the Statistical Package for the Social Sciences Statistics 25.0 (IBM SPSS Corp., Armonk, NY, ABD) package program. In statistical analysis of data Friedman test was used and then analysed using Wilcoxon binary comparison test.

RESULTS

The sprint time data of the three protocols are presented in Table 2. The sprint times, which were measured according to the 85 % PAP protocol, a comparison was made between the 20 m sprint performances after recovery durations of 15 seconds, 4 minutes and 8 minutes. There were significant differences between the sprint times in the 20 m sprint performances, which were performed after different recovery durations following 85% PAP (Figure 1). Looking at the 20 m sprint times following the 85% PAP protocol, a significant difference was found between the sprint performances after 4-8 minutes of recovery duration and the sprint performances after 15 seconds of recovery duration (p = .012; .011). When the sprint performances after 4 and 8 minutes of recovery duration were compared, the best sprint performance was observed in sprint time after 8 minutes of recovery duration (p = .033).

Table 2. Sprint times (mean 90%) at baseline and different times points after the 85% 1RM hip thrust, corresponding effects sizes and qualitative inferences.

Protocol	N	Variable	15 s Rest.	4 min Rest.	8 min Rest.	Qualitative Inference		
						15s	4 min	8 min
85% PAP	9	20 meters	3.19	3.09	3.05	Most likely trivial	Very likely beneficial	Very likely beneficial

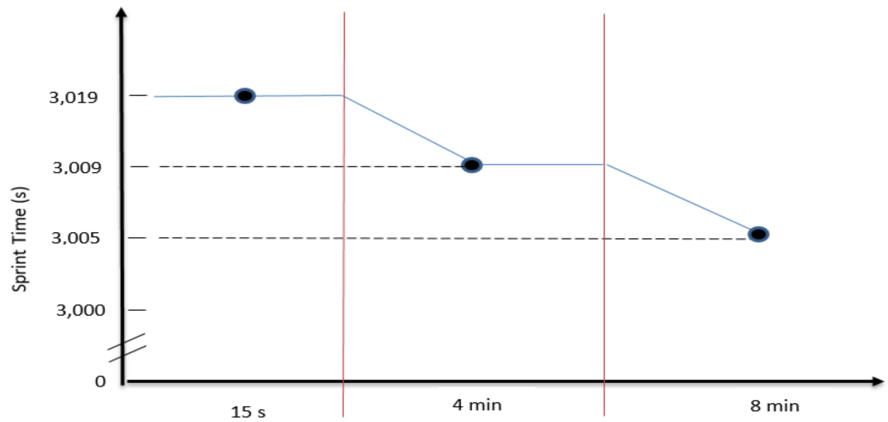

Figure 1. Plot of the time course effects following the% 85PAP protocol on 20-meter sprint performance. There was a statistical significance in the means compared to baseline following the 85PAP protocol; data were presented as means ± SD.

Table 3. Descriptive statistics results of the 20-meter sprint performances with 85% PAP protocol.

Protocol	n	Mean	SD	Min.	Max.
PAP15s Rest.	9	3.19	.13	2.90	3.36
PAP4m Rest.	9	3.09	.20	2.70	3.29
PAP8m Rest.	9	3.05	.21	2.65	3.25

Note. SD, standard deviation; min, minimum; max, maximum; n, number of people; PAP15s Rest, post activation potentiation after 15 seconds rest; PAP4m Rest, post activation potentiation after 4 minutes rest; PAP8m Rest, , post activation potentiation after 8 minutes rest.

Table 4. Comparison of trial times.

PAP4m - PAP15s	PAP8m - PAP15s	PAP4m - PAP8m
-2.521b	-2.547b	-2.136b
.012	.011	.033

Note. PAP4m - PAP15s, Post activation potential Difference between 4 minutes and 15 seconds; PAP8m - PAP15s, Post activation potential Difference between 8 minutes and 15 seconds; PAP4m - PAP8m Post activation potential Difference between 4 minutes and 8 minutes. Note: After 15 seconds, 4 minutes and 8 minutes of rest, the sprint performance showed a significant difference in resting for all durations ($p < .05$).

DISCUSSION

Researchers, who examined the mechanism behind PAP following complex strength training, established a relationship between post-activation potentiation and improvements in speed and explosive strength of athletes. Most of the papers have confirmed the effectiveness of PAP in eliciting performance in tasks requiring speed, jumping ability and agility in soccer players (Pajerska et al., 2020).

In a study by (Dello et al., 2018) carried out with 18 male handball players, a significant difference was observed in sprint performances of 10 meters and 15 meters after 4 minutes and 8 minutes rest after loading with barbell hip thrust with 85% 1RM. This study showed that both moderate and intensive BHT exercises could induce a PAP response; however the effects could differ according to the recovery following the potentiating stimulus and the strength level of the individual.

In a study by (Dello and Seitz, 2018) carried out with 18 football players, a significant difference was observed in sprint performances of 5 meters, 10 meters and 20 meters after 15 seconds, 4 minutes and 8 minutes rest following the loading with barbell hip thrust with 85% 1RM ($p < .05$). Barbell Back Squat is a highly effective training stimulus that enhances the features of the lower body such as strength, speed, and sprint. Athletic performance is considered to be the key component in many sports branches. Barbell Hip Thrust Exercise makes use of a similar muscular system and is a popular exercise among practitioners. However, there are very few academic studies.

In a study by (Millar et al., 2020), a resistance training program was developed consisting of barbell hip thrust and back squat exercises to evaluate the physical performance of female footballers. As a result of the study, it was determined that the barbell hip thrust and back squat movements were both effective stimulants for this sports branch.

In a study performed by (Rahimi, 2007), 12 male elite league players was administered 60%, 70% and 85% squat with 1RM followed by a 40-meter sprint and 4-minute rest PAP protocol. Following the PAP protocol, a significant difference was observed in loads with 70% and 85% power followed by 4 minutes of rest. In our study, declines were observed in all sprint times after all intervals following the 85% PAP protocol.

Similarly, in a study conducted by (Wyland et al., 2015), on 20 male individuals who were engaged in recreational weight exercise, the 10-meter sprint performance was observed after 1 minute, 2 minutes, 3 minutes and 4 minutes of rest following the back squat movement with 1RM 85% loading, and a more decrease was observed in the sprint times in the 10-meter sprint performance after 4 minutes of rest when compared to other minutes of rest ($p < .05$).

In the study conducted by (Chatzopoulos et al., 2007) with 15 male athletes competing in different branches of amateur leagues, no significant difference was found 30-meter sprint performances after 3-minute and 5-minute rests following the back squat exercise with the 1RM 90% PAP protocol; however, significant differences were observed in the 0-10 meter and 0-30 meter sprint tests followed by a 5-minute rest.

In a study conducted by (Bevan et al., 2010), with 16 male rugby players, 5 meter and 10 meter sprint performances after back squat exercise with 1RM 90% PAP protocol followed by 4, 8, 12 and 16 minutes of rest, no difference was observed in the 5 and 10 meter sprint performances; however, individual differences were observed between the best sprint times in the 5 meter and 10 meter sprint tests.

In a study conducted by (Loturco et al., 2018), with elite athletes, the relationship between vertical and horizontal strength exercises with sprint performances of 10, 20, 40, 60, 100 and 150 meters was analysed and it was observed that particularly the barbell hip thrust movement demonstrated a high correlation in the 10-meter acceleration phase.

In our study, when the sprint values of the participants were analysed individually after the barbell hip thrust movement, it was observed that the sprint scores decreased after 15s, 4 and 8 minutes of rest in the 20-meter acceleration phase. Performance improved as the resting time increased.

In the study carried out by (Till & Cooke, 2009), on male academy football players, the effect of post activation potential on the sprint performance and vertical jump length of male academy football players was analysed. According to the 10-meter and 20-meter vertical jump performances deadlift exercise with 80% 1RM loading followed by 4 minutes of rest, a significant difference was observed in the 20-meter sprint performance compared to the 10-meter sprint performance. In terms of the vertical jump performance, a greater performance outcome was observed when compared to the sprint performance of 10 meters and 20 meters.

In a study carried out by (Contreras et al., 2017), on adolescent rugby players, a comparison was made between the groups in 10-meter and 20-meter sprint performances of back squat and barbell hip thrust trainings following a 6-week back squat and barbell hip thrust exercise protocol. A decrease was observed in the sprint scores obtained in the 10-meter and 20-meter sprint tests by the group, which performed the barbell hip thrust exercise, when compared to the back squat group.

In our study, the acute effect was observed after resting for 15 seconds, 4 minutes and 8 minutes following the barbell hip thrust workouts, and decreases were observed in 20-meter sprint performances. Due to the high level of muscle activation of barbell hip thrust workouts in the hip region, acute and chronic decreases were observed in sprint performances of 0-10, 0-20, 0-30 meters after the workouts. Although this effect was a chronic effect; this result was supported in many resources indicating the fact that the barbell hip thrust workouts caused in more muscle activation in the hip region compared to the back squat training.

In another study that was parallel to our study, (Orjalo, 2019) investigated the effect of Barbell Hip Thrust movement on direction change performance with a total of 40 people who were doing recreational sports in groups of female and male. After the PAP protocol with 85% RM, the 505 COD test was administered. Before the 505 COD test was administered, the 505 COD test performances of the participants were evaluated after 4, 8, 12 and 16 minutes. There was an increase in the 505 COD test performances after all the resting periods following the PAP protocol.

This result stems from the improvement in the movement patterns in the vertical direction after the strength workouts that were performed in the vertical direction biomechanically. In the strength workouts performed in the horizontal direction, the movement patterns in the horizontal direction improved. In the studies carried out, a parallelism is observed on the sprint performance with the force output in the horizontal direction. This study showed that intensive BHT exercise could increase the PAP effect. It was also found that the effect of the intensive BHT could vary according to the strength level of the individual. As the previous studies demonstrated, the activation of the muscles in the gluteal region was high in BHT exercises; and the activation of the muscles in the hip region was quite high in the exercises such as sprint. Another conclusion from this study was that the choice of movement for regions with high muscle activations during the movement pattern could provide a positive transfer of movement to the performance. At the same time, the exercises performed in the horizontal direction could have positive contributions to the exercises such as sprint, which were performed in the horizontal direction, due to the fact that both exercises were performed in the same movement pattern. Decreases could be observed in the sprint times as the resting periods are increased; this could be associated with the regeneration of tap creatine phosphate located in the muscle.

CONCLUSION

All variables initially produced highly reliable data. Comparing 20-meter sprint performances after 15 seconds, 4-minute and 8-minute rests by making 85% PAP protocol, significant differences were detected in the 20-meter sprint performances of the athletes (Table 1). Significant differences following the PAP protocols were also evident, as supported by large effects and qualitative outcomes (Table 4). After performing 85 PAP, beneficial and possible positive effects were observed. In the light of this information, improvements in 20m performances were noticed at 4 and 8 minutes time points (Table 2).

Looking at the 20-meter sprint times obtained after the 85% PAP protocol, a positive difference was observed in the sprint performances performed after 4 and 8 minutes of rest compared to the sprint performance performed after 15 seconds of rest ($p < .05$). When 4 and 8 minute sprint performances were compared, a positive difference was observed in the sprint performance performed after 8 minutes rest with the 85% PAP protocol compared to the 4 minute sprint performance ($p < .05$) (Table 4).As a result, a greater increase and development was observed in the 8-minute 85% PAP protocol compared to the 15-minute and 4-minute 85% PAP protocol (Table 2).

AUTHOR CONTRIBUTIONS

These should be presented as follows: Initials (Vurmaz, M. O.) and Initials (Bingül, Meriç, B) were used to design the study. Initials (Vurmaz, M. O.) performed the research. Initials (Akdeniz,H) provided help and advice on research and discussion. Initials (Kösemen, D, S) analysed the data. Initials Vurmaz, M, O., Kösemen S. D., Akdeniz, H., Alpay, D. A., Bingül, Meriç, B, S., and Töre, Ağca, Ö) wrote the manuscript. All authors contributed to the editorial changes in the manuscript. All authors have read and approved the final version of the manuscript.

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DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

AVAILABILITY OF DATA AND MATERIALS

The data presented in this study are available on reasonable request from the corresponding author.

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