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ORIGINAL ARTICLE

Acute Effects of Post-Activation Potentiation on Explosive Strength Performance in Wrestling Athletes

ŞEREF EROĞLU[1]
[1]*Department of Sports Sciences, Hitit University, Physical Education and Sports Department, Ankara, Turkey. seref_eroglu@hotmail.com*
Correspondence to: Şeref Eroğlu, Email: seref_eroglu@hotmail.com

ABSTRACT

Background: Researching methods of improving athlete performance has always been a topical issue. When the studies conducted in this context are examined, many different applications and methods of improving sportive performance have been tested. Especially Post-Activation Potential (PAP) is a very popular subject, and the lack of consensus among researchers on how long the rest period will be after PAP application makes this subject worth investigating.

Aim: The aim of this research is to determine the most appropriate resting time interval to produce the highest explosive power after the PAP protocol.

Methods: The mean age of the participants group of the research was 19,31±1,21, their height was 170,31±3,42, their weight was 69,09±4,06 and their maximal squat one repetition performance (1-RM) was 86,36±5,60. In this research, measurements were completed on five separate days with 72 hour intervals. On the first measurement day, the athletes' height and weight measurements, 1-RM squat measurements, vertical jump performance measurements were taken and explosive strength levels were calculated using the Lewis formula. On the second measurement day, 5 repetitions were performed with 85% of the 1-RM squat and after 15 seconds of rest, the vertical jump performance test was measured. On the third measurement day, 5 repetitions of 1-RM squats with 85% were performed and after 3 minutes of rest, the vertical jump performance test was measured. On the fourth measurement day, 5 repetitions of 1-RM squat with 85% were performed and after a rest period of 6 minutes, the vertical jump performance test was measured. Finally, on the fifth measurement day, 5 repetitions of 1-RM squats with 85% were performed and after 9 minutes of rest, the vertical jump performance test was measured. After all measurements, explosive strength levels were calculated using Lewis formula. Passive rest was performed between the exercise and the measurement.

Results: As a result of the findings of our research, it was determined that the 15-second rest time interval after the PAP protocol negatively affected the explosive strength performance level. In addition, there was no statistically significant difference between 3 min, 6 min and 9 min rest time intervals.

Conclusion: It can be said that the most appropriate resting time is between 3-9 minutes in terms of increasing the explosive strength performance of wrestlers after the PAP protocol.

Keywords: PAP, wrestlers, explosive power.

INTRODUCTION

Researching methods of improving athlete performance has always been a topical issue. When the studies conducted in this context are examined, electrical muscle stimulation training[1,2,3], different warm-up protocols[4-5], massage[6], mental training methods[7,8], Post-Activation Potential applications[9,10] (PAP) and many other methods have been the subject of research to increase sportive performance. In particular, the lack of consensus among researchers on PAP applications makes this subject worth researching.

The concept of PAP describes a phenomenon in which muscle performance is acutely increased as a result of previous contractile events[11]. PAP; It is a physiological phenomenon that characterizes an acute increase in muscle power production and potentially performance in response to a preloaded exercise[12]. Therefore, PAP is also described as a warm-up application by many researchers.

The athletic success of the athletes is of course based on performing a performance at the highest level. For years, coaches and athletes have recommended warming up before competition and training to increase joint range of motion, reduce muscle pain and improve competition performance[13,14]. It is a fact that warming up affects performance through various mechanisms.

There are three theories in the literature that physiologically explain the increase in sportive performance as a result of PAP. The first theory is that stimulation by PAP phosphorylates the regulatory light chain of myosin and moves them from the thick body of myosin, bringing them closer to the thin filaments of actin. It also argues that it will increase the sensitivity to the Ca^{+2} ion, which facilitates interactions within the sarcomere[15]. According to the second theory, it is stated that preloaded preparatory studies such as PAP may be responsible for increasing the permeability of excitation potentials at the synaptic junction and spinal cord levels[16]. According to the third theory; It has been stated that an amplified stimulus can cause a decrease in the pennate angle of the muscle, and as a result, it can cause an increase in power and strength by allowing the power to be transferred from the muscle fiber to the tendon more directly[17]. For these reasons, it has been stated in many studies that PAP protocols can play a key role in increasing sportive performance [10,18-21]. It is very important to develop sportive performance parameters specific to the branch. Especially in sports branches such as taekwondo, judo and wrestling, athletes should have many sportive features.

Sports performance parameters such as aerobic and anaerobic power capacity, muscle strength and endurance, speed, coordination, flexibility and reaction time are very important in wrestling[22]. In this context, it is very important to determine the effect of PAP application on the explosive force performance of wrestlers.

Aim of the study: The aim of this research is to determine the most appropriate resting time interval to produce the highest explosive power after the PAP protocol.

MATERIAL AND METHODS

This cross-sectional study was designed using quantitative research methods.

Participants and Measurement Tools: The participant group of this study consisted of 22 athletes between the ages of 18-21 who have been wrestling for at least three years. The heights of the participants were measured with a wall-mounted stadiometer (Holtain Ltd. England), and their body weights were measured with an electronic scale (Seca, Germany). The maximal strength performances of the participants were determined with the 1-maximal repeat squat test (1-RM)[3,23]. The vertical jump test protocol[24] was used to determine explosive force performances. Lewis formula[25,26] was used to determine the explosive power performance levels of the athletes.

PAP Protocol: "On the first measurement day, the athletes' height and weight measurements, 1-RM squat measurements, vertical jump performance measurements were taken and explosive

strength levels were calculated using the Lewis formula. On the second measurement day, 5 repetitions were performed with 85% of the 1-RM squat and after 15 seconds of rest, the vertical jump performance test was measured. On the third measurement day, 5 repetitions of 1-RM squats with 85% were performed and after 3 minutes of rest, the vertical jump performance test was measured. On the fourth measurement day, 5 repetitions of 1-RM squat with 85% were performed and after a rest period of 6 minutes, the vertical jump performance test was measured. Finally, on the fifth measurement day, 5 repetitions of 1-RM squats with 85% were performed and after 9 minutes of rest, the vertical jump performance test was measured. After all measurements, explosive strength levels were calculated using Lewis formula. Passive rest was performed between the exercise and the measurement" [8].

Statistical Analysis: Data were analyzed using the IBM Statistics (SPSS version 26.0, Armonk, NY) package program. Descriptive statistics for the age, height and body weight of the athletes participating in the study were calculated. The normality distributions of the data were examined. The repeated measures ANOVA test was used to test the difference between the explosive force performances of the participants.

RESULTS

The findings of this study are given in the tables below (table 1; Table 2; Table 3).

Table 1: Descriptive statistics of the participant group of the research

Variables	N	Mean	Std. Deviation
Age	22	19,3182	1,21052
Height	22	170,3182	3,42799
Weight	22	69,0909	4,06974
1-MR squat performance	22	86,3636	5,60226
Explosive strength performance after 15 sec recovery	22	13,8895	,84323
Explosive strength performance after 3 min recovery	22	14,7332	,57333
Explosive strength performance after 6 min recovery	22	14,7405	,51845
Explosive strength performance after 9 min recovery	22	14,7073	,52040

When Table 1 was examined, it was seen that the mean age of the research participant group was 19,31±1,21, their height was 170,31±3,42, their weight was 69,09±4,06 and their 1-RM was 86,36±5,60. When the table 1 was examined in terms of the resting times of the participant group in PAP application, the explosive strength performances of the participants after the 15 sec recovery period was 13,88±,84, after the 3 min recovery period was 14,73±,57, after the 6 min recovery period was 14,74±,51, after the 9 min recovery period was 14,70±,52.

Table 2: Results of repeated measures ANOVA analysis

Type III Sum of Squares		df	Mean Square	F	p	Partial Eta Squared
Recovery time interval	11,584	3	3,861	13,049	,00	,383
Error	18,643	63	,296			

When Table 2 was examined, it was determined that the performance levels of the participants showed a significant difference after four different rest periods (p<.05).

Bonferroni multiple comparison test was used to determine which recovery time was significantly different. As a result of Bonferroni multiple comparison test, it was determined that there was a significant difference between the explosive strength performance levels of the participants after 15 seconds of recovery and 3 minutes, 6 minutes and 9 minutes of recovery (p<.05). However, after 3 minutes, 6 minutes and 9 minutes recovery times, there was no statistically significant difference between explosive strength performance levels.

Table 3: Recovery time multiple comparison test results

Recovery time (I)	Recovery time (J)	Mean Difference (I-J)	Std. Error	p
15 seconds	3 minutes	-,844*	,192	,002
	6 minutes	-,851*	,202	,002
	9 minutes	-,818*	,159	,000
3 minutes	15 seconds	,844*	,192	,002
	6 minutes	-,007	,160	1,000
	9 minutes	,026	,117	1,000
6 minutes	15 seconds	,851*	,202	,002
	3 minutes	,007	,160	1,000
	9 minutes	,033	,139	1,000
9 minutes	15 seconds	,818*	,159	,000
	3 minutes	-,026	,117	1,000
	6 minutes	-,033	,139	1,000

DISCUSSION

As a result of this research, which was carried out to determine the most appropriate rest interval to produce the highest explosive power after the PAP protocol, it was determined that the explosive force performance level was affected by some rest intervals. As a result of our research, it was determined that the 15-second rest time interval after the PAP protocol negatively affected the explosive strength performance level. However, there was no statistically significant difference between the 3 min, 6 min and 9 min rest time intervals.

In some studies, it has been reported that high-intensity warming with preload causes muscle fatigue and therefore jumping performance is negatively affected[18,27,28]. Accordingly, it can be said that optimal performance can be produced when muscle fatigue is reduced[8].

When the literature about what is the most appropriate rest interval after the PAP protocol is examined, it has been seen that there are various time intervals.

Timon et al. (2019) stated in their study that after the PAP protocol, it had a positive effect on vertical jump performance between 4 and 8 minutes in order to achieve the highest sportive performance[29]. Şentürk et al. (2019) reported in their study that the most appropriate time to achieve the highest sportive performance after the PAP protocol is 8 minutes[30]. Cuenca-Fernandez (2015) reported in their study that an 8-minute rest interval after PAP protocols can increase sportive performance[31]. Beato et al. (2019) reported that there may be an increase in some sportive performance parameters after a 4-minute rest period after the PAP protoco[32,37,38]. Beato et al. (2020) stated in their study that a 5-minute rest period after PAP protocol can increase sportive performance[33]. In the study conducted by De Keijzer et al. (2020), it was stated that the highest vertical jump performance after the PAP protocol emerged after a 6-minute rest period[34,35,36]. In a similar study conducted by Kilincarslan et al. (2022), it was reported that the highest vertical jump performance after the PAP protocol emerged after a 6-minute rest period and a decrease was observed after 9 minutes[8]. Based on all these findings in the literature and the findings of our research, it can be said that the most appropriate resting time is between 3-9 minutes for the increase in sportive performance after the PAP protocol.

In order to determine more specific time intervals within the scope of the PAP protocol, it may be recommended to conduct new studies by considering the intensity, repetitions and set numbers applied in the PAP protocol.

CONCLUSION

It has been emphasized in many scientific studies that sportive performance can increase after the PAP protocol. Although there is no consensus on what the rest period will be after the PAP protocol, many researchers have stated that it can be effective between 4 and 8 minutes. As a result of our research, it was determined that the sportive performance decreased after the 15-second rest period after the PAP protocol, but increased between 3-9 minutes. However, it was also determined that there was no

statistical difference between the 3-6-9 minute rest period. In summary, it can be said that the rest period of 3-9 minutes after the PAP protocol is an appropriate rest period in terms of increasing the sportive performance.

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