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Effects of the Preload Post-Activation Potential on Sprint Performance

INVESTIGATION OF ACUTE EFFECT OF PRELOAD POST-ACTIVATION POTENTIAL APPLIED IN BICYCLE ERGOMETER ON 6-SECOND SPRINT PERFORMANCE

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Authors' Contribution: A: Study design, B: Data collection, C: Data analysis, D: Manuscript preparation, E: Discussion and conclusion

ABSTRACT

Study aim(s): The purpose of the present paper was to investigate the acute effect of the Post Activation Potential (PAP) applied in the bicycle ergometer on 6-second sprint performance. Although the post-activation potential decreases over time, like fatigue, it continues for some time following the disappearance of fatigue. Another purpose of the study was to examine the effect that continues at regular intervals in this process where the effects of fatigue decrease and potentization continue.

Methods: A total of 18 male Physical Education and Sports School students who were aged 22-25 were voluntarily included in this study. The average height of the participants was 176 cm, the average weight was 74 kg, the average body fat ratio was 15.8%, and the body muscle weight was 35. A Watt bike Bicycle Ergometer was used for the tests. In this study, in which the Wingate Test was used for pre-loading, the same ergometer was used to determine the 6-second sprint performance according to times.

Results: As a result of the measurements, following the 6-second sprint test performed at the 5th minute following Wingate loading, the PAP effect was observed and a significant difference was detected when compared to the first measurements. After the preload measurement was applied in the same way, following the measurement taken at the 10th and 15th minutes, the watt values increased, but the load increase was at the 5th minute.

Conclusions: As a result, in the present study, it was determined that the PAP protocol was made within 30-sec. sprint test preload was effective in creating the post-activation effect, and it was found that there was a significant difference when compared to the protocol without preload. Considering the durations, although the first test result following Wingate loading showed a significant difference in 6-second sprint watt values, it was observed that the effect of PAP decreased over time.

Keywords: PAP, Acute Effects, Wingate, Sprint.

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INTRODUCTION

A theory states that a muscle contraction with a post-activation potential enhances the intensity of a second contraction. There's another method in which dynamic exercises and jump-type dynamic movements are used. In general, it was desirable to perform movements at high intensities and for a short time, in which the main purpose was to prepare the muscle for loading and to provide extra muscle contractions [1].

It seemed that the use of different warming strategies to increase neuromuscular efficiency was suggested in the literature to improve performance during the next cycle effort through Post-activation Potentiation (PAP) [2]. Post-activation potentiation was defined as the acute recovery of muscle function following a voluntary contraction [3].

One of the key factors to optimize the PAP effect was to include conditioning activities mimicking the movement patterns of the next activity. For this reason, examining a PAP effect by using cycling-based exercises could increase performance improvement at the desired level [4]. Also, it is known that the protocols in the bicycle ergometer were more efficient in terms of ease of application and controllability [5].

Although current studies have shown the positive effects of different PAP protocols on the supramaximal cycle, the relative contribution of both metabolic and neuromuscular factors to observed performance was not clear yet. However, the current literature suggests that the PAP effect seen at the 4th minute was predominantly peripherally mediated in a high-intensity PAP protocol, while the PAP effect at the 16th minute was more neural [6]. It was mentioned in the literature that it was more specifically related to joint angle and range of motion in dynamic contractions [3].

When the general literature was reviewed, the effect of PAP up to the 15th minute was included in studies, but there was no clear opinion on this issue because of the scarcity of tests and measurements in the bicycle ergometer. It was already known that optimal warm-up was important because cycling was a sport in which, due to its nature, in-race attacks, sprint finishes, and especially the sprint feature in track cycling were at the forefront. For this reason, the time between the warm-up and the maximal sprint was also important in this regard.

For this reason, the purpose of the present paper was to determine the post-activation potential (PAP) applied in the bicycle ergometer for 6 seconds. It also aimed to examine the acute effects on sprint performance. Although the post-activation potential decreases over time (like fatigue), it continued for some time following the disappearance of fatigue [7]. Another purpose of this paper was to examine the effects that continued at regular intervals in this process where the effects of fatigue decreased and potentization continued.

METHODS

Research design

The present study was conducted with a single-group pre-test-post-test design [8]. Each participant participated in the test 2 times in total. On the first day, the athletes were first measured in terms of height, body weight, and body fat percentage, then following 5 minutes of warming up for familiarization, they were subjected to 5 minutes of passive rest, and a 6-second sprint attempt, 48 hours later, following 5 minutes of warming up at 60 watts, again. The Wingate Test was taken by subjecting to 5 minutes of passive resting. A 6-second sprint test was taken on the Wattbike Device on the measurement day. This measurement was included as a preliminary test of the study. After the first measurement day, at least 48 hours and at most 72 hours following the post-test measurements, the participants were subjected to the maximal performance test on the bicycle ergometer for 30 seconds following warming up and 5 minutes. After the passive resting intervals and following the 5th, 10th, and 15th minutes, the watt values were observed depending on time.

Study sample

A total of 18 male Physical Education and Sports School students who were aged 22-25 were voluntarily included in the study. The average height of the participants was 176 cm, the average weight was 74 kg, the average body fat ratio was 15.8%, and the body muscle weight was 35. Before the data were collected, the participants were informed about the test procedures, and the participants were informed that they should avoid alcohol, caffeine, and ergogenic supplements on the day of the measurements and the day before.

Before the study commenced, all participants were asked to read and sign the voluntary consent form, and the study was conducted in line with the principles of the Declaration of Helsinki.

Data collections tools

Height: The height of the participants was taken with a SECA-brand height measuring device in the anatomical position, barefoot, and head in the frontal plane.

Body Weight: The body weight measurements of the participants were made in standard sports clothes (shorts and t-shirt) and bare feet on a scale (INBODY 270) that had an accuracy of 0.1 kg.

6-sec. Sprint Test: The Watt bike Bicycle Ergometer was used for the test along with the Wingate Test, which was one of the bicycle tests. The participants rested for 5 minutes following warming up for 5 minutes and a 6-second sprint test was applied. The test was conducted by entering the kg values of the participants and giving the appropriate resistance setting by the Watt bike device during the application phase of the test [9].

Wingate Test: A Watt bike Bicycle Ergometer was used for the test. The validity and reliability study of the Watt bike Device was conducted by Hopker et al. [10]. The handlebar height was adjusted for each participant and the feet were fixed with the clips on the pedals. The subjects cycled for the first 5 minutes and warmed up at 60 watts on average. After a resting period of 5 minutes, the pedaling speed was calculated for 30 seconds, following the end of the 30 seconds, the subjects rested for 5 minutes and the 6-second sprint tests were repeated 3 times, with 5 minutes resting times between each repetition [9].

Data analysis

The performance data obtained as a result of the tests that were applied to physical education and sports school students were analyzed in the SPSS 26.0 statistical package program. It was determined with the Shapiro-Wilk test that the data were normally distributed and the differences between the applications were examined with ANOVA (Analysis of Variance in repeated measures). The Bonferroni Post-Hoc Test was used to determine which group or groups caused the difference and the significance level was taken as 0.05.

FINDINGS

Table 1. Descriptive statistics of body composition variables included in the study

Variables	N	Min	Max	X̄±SD
H (cm)	16	167,0	193,0	176,8±6.84
W (kg)	16	59,0	95,3	74,9±11,11
BF% (%)	16	6,5	28,8	15,8±5,67
MM (kg)	16	26,9	47,2	35,9±5,74

H: Height, W: Weight, BF%: Body Fat Percentage, MM: Muscle Mass

According to the descriptive information given in Table 1, the height of the sports science students participating in the study was 176.0 ± 6.84 cm, their body weight was 74.9 ± 11.1 kg, their body fat ratio was 15.8 ± 5.6, and their body muscle weight was 35.9 ± 5.74.

Table 2. The values according to 30-sec sprint post-loading times

M	LI	X̄±SD	LV	HV
1	Pre-test	943,0±44,1	848,957	1037,043
2	Last 5	1043,9±43,8	950,573	1137,302
3	Last 10	960,2±37,8	879,653	1040,880
4	Last 15	976,0±41,3	887,890	1064,243

*M: Measurements, LI: Load intervals (watt), LV: Lowest values, HW: Highest value, *95% Confidence Interval*

When the variables in the study were examined, it was found that the sports science students participating in the study had an average of 943 watts at the preload of the 6 seconds sprint test following 5 minutes of passive rest following 30 seconds of Wingate test, and the wattage values following 5 minutes of rest were 1043, 960, and 976 watts.

When Figure 1 was examined, it was seen that following the Wingate test, the greatest PAP effect was at the 5th minute and it decreased to the first watt values at the 10th minute

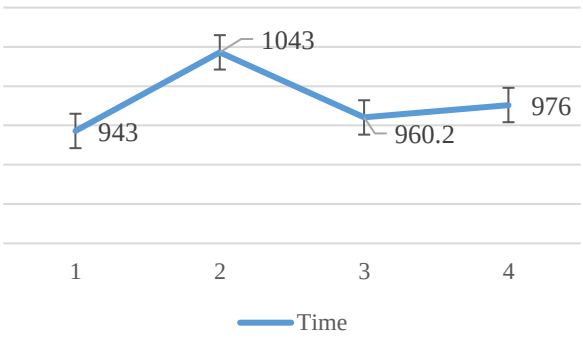

Figure 1. Acute effect of PAP on the sprint performance

When Table 3 is examined, it is seen that there were significant differences between the pre-test and Last 5, Last 5 and Last 10, and Last 15 and Last 5.

When looking at the variable that caused the difference, it was found that the group average strength increased in the 6-second Sprint test applied in the 5th minute following the pre-test and the Last 5 averages. Similarly, following the preload measurement, the watt values increased as a result of the measurement taken at the 10th and 15th minutes, but it was seen that the highest load increase was at the 5th minute.

Table 3: One-Way Analysis of Variance in repeated measurements of 6-sec sprint values following loading (Wingate)

	Variables	X̄±SD	Difference	LV	HV
Pre-test	Last 5	-100,938*±18,579	,000	-157,350	-44,525
	Last 10	-17,267±19,708	1,000	-77,107	42,574
	Last 15	-33,067±22,973	1,000	-102,819	36,686
Last 5	Pre-test	100,938*±18,579	,000	44,525	157,350
	Last 10	83,671*±11,679	,000	48,211	119,131
	Last 15	67,871*±16,702	,006	17,159	118,583
Last 10	Pre-test	17,267±19,708	1,000	-42,574	77,107
	Last 5	-83,671*±11,679	,000	-119,131	-48,211
	Last 15	-15,800±12,930	1,000	-55,058	23,458
Last 15	Pre-test	33,067±22,973	1,000	-36,686	102,819
	Last 5	-67,871*±16,702	,006	-118,583	-17,159
	Last 10	15,800±12,930	1,000	-23,458	55,058

**0,05, Pre-test: 6 sec. Pre-loading test, Last 5: Fifth minute 6 sec. Sprint test, Last 10: Tenth minute 6-sec. Sprint test, Last 15: Fifteenth minute 6-sec. Sprint test., Lowest values, HW: Highest value*

DISCUSSION

It was seen that the results of the present study, which was conducted to examine the acute effect of the post-activation potential (PAP) applied in the bicycle ergometer on the 6-sec sprint performance, affect the 6-sec sprint performance of the PAP protocol applied with the Wingate preload and these results are similar to the literature. A significant difference was found between the 6-sec sprint test and the 6-sec sprint test applied at the 5th and 10th minutes following the Wingate loading, and between the 15th and the 5th minutes following the Wingate loading.

When examining the variable, the difference originated from, it was found that in the pre-test and Post 5 averages, it was observed that the group average strength increased in the 6-second sprint test applied at the 5th minute following the preload. Similarly, following the preload measurement, the watt values increased as a result of the measurement taken at the 10th and 15th minutes, but it was seen that the greatest increase was at the 5th minute.

Previous studies showed that PAP protocols applied with maximal performance increase jump or sprint performance [11]. In a study that was conducted by Doma et al. [12] in the literature, a positive significant difference was obtained in the mean watt values at the 5th and 10th minutes in the Wingate test protocol applied following the 10-second preload protocol with the bicycle ergometer. The results were similar to the present study. This study emphasizes that high-intensity preloads over 10 seconds increase sprint performance.

Studies indicating that the PAP response was affected by the rest periods have stated that the rest periods vary according to the power level and professional level of the athlete. In Wilson et al.'s meta-analysis [13] it was stated that 3-7 minutes of recovery time for professional athletes after a preconditioning activity is the ideal time for the best power output. They say that as the level of experience of the athletes decreases, they can provide the best power output after this period was increased to 7-10 minutes of rest.

In another study, following the high-intensity warm-up protocol in the bicycle ergometer, no

significant increase was detected in the 4th minute of the 6-second sprint test applied at the 4th, 8th, 12th, and 20th minutes, and a significant increase was detected in the 12th minute [5]. This study showed that sprint performance was improved by using a high-intensity preload in the bicycle ergometer.

However, although there was a great deal of data on the effects of PAP in the literature, there were not enough studies on bicycle-based PAP protocols. For this reason, in the present study, it was possible to foresee that the decrease in the effect of PAP at the 10th and 15th minutes was because of factors such as individual responses to PAP, fatigue, training age, biological age, muscle fiber type, and muscle strength.

CONCLUSIONS

In conclusion, in this study, it was determined that the PAP protocol made with a 30-sec sprint test preload was effective in creating the post-activation effect, and there was a significant difference when compared to the protocol without preload.

Considering the durations, following Wingate loading, although the first test result following loading showed a significant difference in 6-sec sprint watt values, the effect of PAP decreased over time.

Considering that bicycle-based PAP protocols were few in the literature, it can be argued that the application of PAP protocols with different preloads and different rest periods will contribute to the literature data. Also, designing and developing such studies with the participation of cyclists will contribute to cycling. Another point to be noted in this study was that it was studied with sports science students. It was known that the students were recreationally experienced but had not been tested on the bicycle ergometer before. When the Wingate test was performed with cyclists, it was inevitable to produce more effective results.

CONFLICT OF INTERESTS

No potential conflict of interest was reported by the authors.

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