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Effect of Different Post-Activation Potentiation Intensities on Vertical Jump Performance in University Volleyball Players

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ABSTRACT

Oliveira JJ, Silva AS, Baganha RJ, Barbosa CGR, Silva JAO, Dias RM, Oliveira LHS, Pereira AA, Ribeiro AGSV, Pertille A. Effect of Different Post-Activation Potentiation Intensities on Vertical Jump Performance in University Volleyball Players. **JEPonline** 2018;21(2):90-99. The aim of this study was to analyze the effect of different intensities of PAP on vertical jump performance in university volleyball players. Twelve players performed anthropometric tests, 1 RM (repetition maximum) test in the squatting exercise, and familiarization with the vertical jump test. In subsequent weeks, the subjects underwent 5 more collection sessions with a 24-hr rest interval between them. Prior to each Counter Movement Jump (CMJ) test, the subjects performed an experimental condition: (a) Control; (b) PAP 91% 1RM; (c) PAP 85% 1RM; (d) PAP 70% 1RM; and (e) PAP 60% 1RM. The results showed that the Group submitted to the PAP protocol showed a significant difference in comparison to the Control Group, with higher PAP intensities of 91%, 85%, and 70% of 1 RM verified while the 60% intensity of 1RM showed no significant difference in comparison to the Control Group. The findings indicate that the PAP positively affects the performance of vertical jump in university volleyball players.

Key Words: College Athletes, Ergogenic Resource, Post-Activation Potentiation, Volleyball

INTRODUCTION

In volleyball, players commonly present greater development in specific variables, such as muscle power, speed of reaction and displacement, agility, and vertical impulsion (25). Among these variables, the vertical impulsion along with player height are important variants in the modality and can be an important factor in controlling the match (6,21).

The positive performance of the vertical jump requires a number of factors to be executed and can be highlighted: (a) initial velocity of exit; (b) explosive force; (c) mechanical power of the lower limbs; and (d) speed of leaving the ground, thus leading to a greater reach during the jump vertical (12). In this context, the use of different ergogenic resources to maximize the physical performance and/or the delay fatigue is being studied by the scientific community (4). The term "ergogenic" can be defined as any means used to optimize the response and control of cellular energy, thus providing improvement of physical performance (30,31). Among these ergogenic resources is the post-activation potentiation (PAP), which refers to the increase in muscle strength and power production after previous voluntary contractile activity, usually with intense resistance exercises (19,27).

Post-activation potentiation can be induced by manipulating some variables, such as type of exercise as conditioning activity, number of repetitions, number of sets, interval between PAP and task of interest, and intensity in PAP exercise (29). The intensity of post-activation potentiation exercises may be a limiting factor in physical performance responses, since the intensity imposed by the exercise may influence the response and be insufficient to stimulate potentiation (2). Knowledge about manipulation of optimal intensity to maximize PAP performance is of great interest to the scientific community, exercise physiologists, and trainers. However, presently, the literature is lacking in studies that have compared the effect of different intensities of post-activation potentiation on vertical jump.

Due to the acute improvement of the physical performance by different pathways, our initial hypothesis was that the manipulation of the PAP intensity should result in the improvement of vertical jump height (given that high/moderate intensities should improve the athletes' physical performance response compared to low intensities). Thus, the aim of the present study was to analyze the effect of different intensities of post-activation potentiation on vertical jump performance in university volleyball players.

METHODS

Subjects

Twelve university volleyball players (age 23.3 ± 1.8 yrs, height 1.76 ± 0.1 cm, body mass 69.3 ± 6.9 kg, BMI 22.3 ± 2.2 kg·m⁻²) volunteered to participate in this study. The subjects were informed about the research proposal, detailing the objectives, methodology, benefits, and risks involved. Then, the subjects completed a questionnaire to assess their health status (7), which was followed by the subjects signing the consent form after being informed about the experimental procedures. This study was approved by the Committee of Ethics in Research at the Methodist University of Piracicaba (protocol: 1.717.565).

The inclusion criteria consisted of the following, the subjects: (a) had to have a competitive experience in volleyball for at least 2 yrs; (b) had to attend all the collection visits; (c) did not

suffer any type of injury one month prior to the study getting underway; and (d) were not taking steroids and/or dietary supplements.

Instruments and Procedures

This study was conducted using a randomized, cross-over approach to analyze the effect of different intensities of post-activation potentiation on vertical jump performance in university volleyball players. In the week prior to the study, each subject visited the laboratory at the Federal University of Itajubá once: (a) to characterize the subjects by means of anthropometry; (b) to determine each subject's 1 RM (repetition maximum) in the squat exercise; and (c) to familiarize each subject with the vertical impulse test. This study consisted of 5 sessions with a 24-hr rest interval between each session. Prior to each Vertical Jump Counter Movement Jump (CMJ) test, the subjects underwent an experimental condition: (a) Control; (b) PAP 91% 1RM; (c) PAP 85% 1RM; (d) PAP 70% 1RM; and (e) PAP 60% 1RM.

Prior to each experimental condition, the subjects performed a 5-min warm-up on a stationary bicycle with a load of 75 to 100 W at 70 rotations·min⁻¹. Then, the subjects performed the experimental condition, and after 8 min of passive recovery they underwent the test (3,15). All subjects were instructed not to engage in strenuous efforts during the research period and to maintain their regular feeding routines. Figure 1 shows the experimental design of the study.

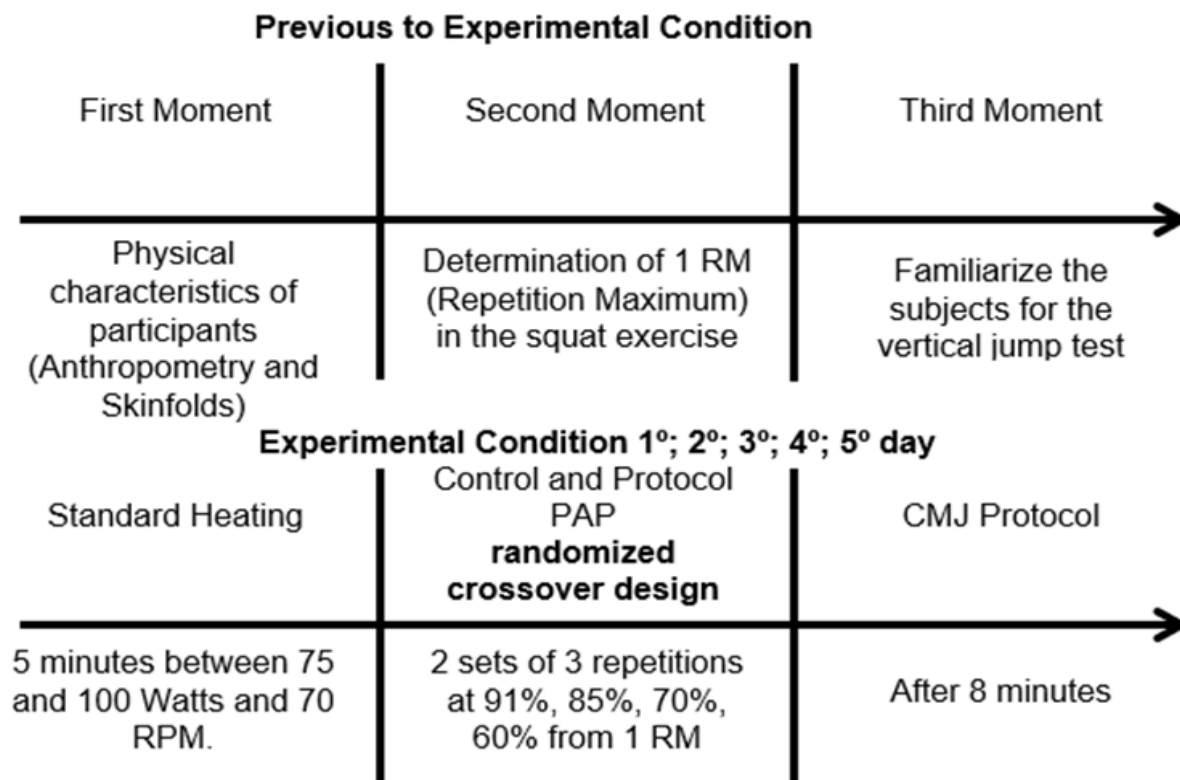


Figure 1: Experimental Design of the Study

Caption: PPA: Postactivation Potentiation; CMJ: Counter Movement Jump; RPM: Rotation Per Minute; RM: Repetition Maximum; Min: Minutes.

Anthropometric Assessment

The subjects were instructed not to exercise and not to drink alcoholic beverages and/or stimulants 24 hrs before the tests, and to consume a light meal 2 hrs prior to the evaluations. All procedures were measured by the same evaluators.

For the analysis of the body composition, the anthropometric evaluation consisted of determining the subjects' height and body mass. For height measurement, an Altuxata stadiometer was used. The equipment presents a scale from 0 to 220 cm with a resolution of 0.1 cm. To measure body mass, a Welmy® mechanical scale with a capacity of up to 180 kg and fractions of 100 gm (23). The body mass index was calculated by dividing the body mass in kilograms by the height in meters squared (13,23,32). The body composition was determined through the thickness of the skinfolds, making three measurements of each anatomical point pre-established on the right side of the body, for recording the mean value. The measurements were performed with a Sanny® brand scientific adipometer. For male athletes, measurements of the subscapular, triceps, pectoral, medial axillary, supra iliac, abdominal, and medial thigh measurements were collected. The equation of Jackson and Pollock (18) was used to determine the body composition values.

Vertical Jump

Analysis of the vertical jump capability was determined by the execution of the Counter Movement Jump (CMJ) on a Jump System Pro from the Cephysiotecnology sports company. Briefly, the SMJ was performed from the mid-squat position (~90° angle of the knee) with the trunk erect and hands positioned at the hips. After verbal instruction, the subject did the vertical jump. The CMJ was performed from the standing position, upright trunk and with both hands at the hips. After verbal instruction, the subject performed knee flexion before jumping vertically. Three attempts were made for each jump with a 10-sec interval between the jumps. For analysis, the highest value obtained was recorded.

Maximum Strength

The determination of maximum muscle strength was performed by means of a maximal repetition test (1RM) in the squat exercise, according to the procedures described by Brown and Weir (5). Each subject did 2 to 3 sets of 5 to 10 replicates with ~40 to 60% estimated 1RM prior to protocol execution. The determination of maximal muscle strength was performed with a maximum number of 5 attempts with intervals of 3 to 5 min of recovery between each. If the attempt was not successful, the external load was adjusted by 5 to 10% until the external load was found to make a maximum movement. The squat exercise was performed using guided bar (Smith equipment).

To validate the 1RM test, the subjects had to perform knee flexion movement up to 90° during the eccentric phase. A researcher monitored the range of motion to validate the test. Two assistants were present next to the exercise bar to ensure the safety of the subjects. The test was performed with a maximum of 5 attempts and 5 min of recovery interval between each attempt. All subjects were familiar with the 1RM test in the squat exercise.

Statistical Analysis

The research data were quantitatively analyzed using descriptive statistical techniques (mean $\pm$ standard deviation). Initially, the normality of the data was analyzed by the Shapiro-Wilk test to identify the characteristics of the data. It was verified that the data are parametric. One - Way analysis of variance (ANOVA) with repeated measures was used, followed by the Bonferroni test for the statistical comparison between the experimental conditions. The percentage variation between the groups ($\Delta\%$) and the trend of the data were also calculated by using the Cohen formula for effect size (9). The threshold of magnitude adopted was: ≤ 0.19 trivial; between 0.20-0.59 small; between 0.60-1.19 moderate; between 1.20-1.99 large; and ≥ 2.00 very large (17).

RESULTS

Table 1 reports the characterization of the sample by mean $\pm$ standard deviation. The comparison of the results between the variables of the Control Group and the PAP Group are presented in Table 2. The group that was submitted to the PAP protocol presented a significant difference of higher values in comparison to the Control Group, with intensities 91%, 85%, and 70% of 1 RM. However, the 60% intensity of 1RM did not present a significant difference in comparison to the Control Group.

Table 1. Characteristics of University Volleyball Players at Baseline (N = 12).

Variable	Mean $\pm$ SD
Age (yrs)	23.3 $\pm$ 1.8
Body mass (kg)	69.3 $\pm$ 6.9
Height (cm)	1.76 $\pm$ 0.1
BMI (kg·m⁻²)	22.3 $\pm$ 2.2
% Fat	10.3 $\pm$ 4.0
Fat Weight	7.3 $\pm$ 3.2
HBW	62.9 $\pm$ 5.9
1RM (kg)	123.3 $\pm$ 16.7

BMI = Body Mass Index; **%** = Percentage; **HBW** = Heavy Body Weight; **1RM** = Repetition Maximum

Table 2. Comparison of the Vertical Jump Performance Against Movement (cm) After Different PAP Intensities.

PAP Intensities	Groups		$\Delta\%$	Effect Size	P<0.05
	Control	PPA			
91% 1RM	43.18 $\pm$ 3.10	46.60 $\pm$ 3.45	7.92	1.04 (moderate)	0.001*
85% 1RM	43.18 $\pm$ 3.10	46.85 $\pm$ 3.45	8.50	1.11 (moderate)	0.002*
70% 1RM	43.18 $\pm$ 3.10	45.64 $\pm$ 3.19	5.70	0.78 (moderate)	0.047*
60% 1RM	43.18 $\pm$ 3.10	44.50 $\pm$ 3.73	3.06	0.38 (small)	0.062

1RM = Repetition Maximum; **PAP** = Post-Activation Potentiation; $\Delta\%$ = Percentage Variation; * = Significant Difference = P $\leq$ 0.05

DISCUSSION

The purpose of the present study was to analyze the effect of different intensities of post-activation potentiation on vertical jump performance in university volleyball players. The main findings of the study indicate the positive effect of the PAP Group compared to the Control Group on vertical jump performance in the 91%, 85%, and 70% intensities of 1RM, while no difference was found for the 60% intensity of 1RM. Thus, an initial hypothesis of the study was confirmed, since PAP with high/moderate intensity significantly impacted the height of vertical jump in university volleyball players. However, it is interesting that Comyns et al. (10) reported that their results were better with jump intensities higher than 80% 1RM. However, our data suggest a positive response from the intensity of 70% of 1RM.

Post-activation potentiation is a phenomenon where there is an increase in the subjects' physical performance after voluntary contraction of high/moderate intensity (that is called contraction conditioning) (16). Apparently, it is related to the increase of acute neuromuscular performance when preceded by an initial voluntary muscular activation with moderate/high intensity (19,27). As the data indicate in the present study, PAP demonstrates a positive effect on the development of muscular strength and power, which are physical responses that are important for a sporting activity such as the vertical jump performance (8,26).

It is noteworthy that the PAP protocol (2 x 3 replicates [60%, 70%, 85%, 91% 1RM, 8-min passive recovery interval]) was applied randomly in the present study and compared to the Control Group at intensities of 70%, 85%, and 91% of 1RM. Previous studies have shown an acute increase without vertical jump performance after PAP in athletes of various sports modalities with high/moderate intensity (11,20,22).

Among the main mechanisms related to the improvement of performance through PAP, it is very likely the result of the increase in the recruitment of high-threshold motor units (1,8) and

the phosphorylation of the regulatory myosin of light chain (14,24). This effect occurs in greater magnitude in type II muscle fibers that favor performance in high-intensity and short-duration activities (27,29).

The evidence is attributed to changes in the magnitude of the intensity of the PAP method, as well as the manipulation of training variables, in addition to the rest interval that precedes the main activity (19,20). In terms of practical implications, the present study provides support for the use of PAP with high/moderate intensity (91%, 85%, and 70% 1RM) prior to vertical jumping in volleyball players as a potential method to improve performance of the jump during the game.

CONCLUSIONS

The findings indicate that PAP has a positive influence on the performance of university volleyball players, and that the effect was significant in the experimental protocol of intensities of 91%, 85%, and 70% of 1RM. However, it is important to point out that the intensity 60% 1RM did not present a significant difference in comparison to the Control Group.

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