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***Key Words:**

Post activation potentiation, Conditioning activity, Shot put

***List of Abbreviation**

PPA : Post Activation Potentiation
FB: Arm Flexion
SV: Vertical Jump
APE: Static Shot Put
Acs: Conditioning Activities

Effect of conditioning activities of upper and lower limbs on the performance of the throttle drop

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Abstract

Introduction: Post-activation potentiation (PPA) is a physiological phenomenon capable of increasing muscle performance during high-intensity physical exercises. The objective of the present study was to evaluate the central and local mechanisms of potentialization of physical performance through conditioning activities of upper and lower limbs, seeking in this way to know which mechanism of potentialization of physical performance brings more significant results and if the flexion exercises of arm and jumps against movements presents significant values to trigger potentiation.

Methodology: The sample consisted of 20 volunteers, 13 male volunteers and 7 female volunteers, practitioners of physical activities for a minimum period of 6 months, aged between 18 and 35 years, where they were randomly assigned to carry out conditioning activities before the shot put.

Results: there were seven positive responses for AC arm flexion and five for AC vertical jumps in men. Women responded less to ACs, with only one positive response to AC arm flexion and three to AC vertical jumps. Discussion: It was possible to identify that volunteers who do not practice strength training in bodybuilding showed negative results in at least one of the conditioning activities. Among the volunteers, they performed various physical activities, which may have affected their performance in each particular research session.

Conclusion: The results of the present study suggest that there is no predominance of central or local mechanisms in triggering APP. However, there was an effect of conditioning activities on throwing performance.

Introduction

Post-activation potentiation is a physiological phenomenon capable of increasing muscle performance during high-intensity physical exercises (BATISTA, 2010).

Chiu et al., (2003) the improvement in performance can be obtained through stimuli for maximal isometric contractions, maximal and submaximal dynamic contractions. Manclntosh et al. (2012) state that the PPA presents great individual variability, which suggests that its presence also depends on the characteristics of the sample and the types of conditioning exercises.

Post-activation potentiation would be caused by performing conditioning exercises before the main activity, leading to an increase in the speed of conduction of nerve impulses to the muscles, in the number of motor units recruited, as well as an improvement in the mechanism of interaction of the contractile filaments. (BATISTA, 2010)

Through these neuromuscular alterations, PPA can contribute to the

improvement of performance in exercises that require strength, power or speed. (XENOFONDOS, 2010).

Rassier (2000) points out that there are mechanisms that determine whether the exercise before the main activity causes “increase” (potentiation) or “decrease” (fatigue) of muscular strength. The interval between the two exercises will determine whether the conditioning exercise will be detrimental or performance enhancing.

According to Kilduff, (2007) if the main activity occurs immediately after the conditioning activity, fatigue could override potentiation. The opposite can occur when enough time is allowed for muscle recovery.

Manclntosh, (2012) states that the ideal time for potentiation is from one to five minutes, as this is the time in which the myosin light chain remains phosphorylated, creating, according to the authors, a “memory” of contraction. Above this period, contraction memory is dissipated and potentiation is impaired.

Borba et al. 2017 states that some authors in their review study on the effects of conditioning activity on performance in athletics tests suggest that, for intervals shorter than one minute, fatigue predominates over potentiation, decreasing performance, while in very long periods above 12 minutes the augmentation would dissipate.

According to Hodgson et al. (2008) the possible physiological mechanisms of APP are related to central and peripheral mechanisms, in which APP can occur due to the change in the pattern of stimulation of motor units, resulting in an increase in the number of excited motor units, improvement in the synchronization of triggers nerves, reduction of central inhibitory mechanisms and increase of reciprocal inhibition of the antagonist musculature. (MANCLNTOSH, 2012)

To achieve PPA, strength/power exercises differ from traditional preparatory exercises (warm-up) in terms of their physiological form and mechanism. The traditional warm-up is composed of low-intensity aerobic activities, stretching exercises of the main muscles and specific movements of the modality, and its duration is quite varied. (BISHOP, 2003)

As its name suggests, the main purpose of warming up is to increase body temperature. The literature also points out that high muscle temperature improves the conduction speed of nerve impulses, which may contribute to the improvement of performance in strength and power exercises. (YOUNG, 1998)

However, PPA can be triggered by exercises that require the production of maximum or close to maximum muscle strength and power, in which exercises with weights and

short-term jumps are used, and its main function is to improve the production of strength and power during effort. . (BATISTA, 2010)

Santos (2017) states that the most used activities for PPA are vertical plyometric jumps, squats and running. However, there is no consensus about which strength exercises are more or less effective in triggering APP. In addition, studies that compared the effects of conditioning activities between upper and lower limbs are still limited. Currently, several types of APP induction protocols are applied in order to improve acute physical performance. (ESFORMES, 2013)

One of the striking characteristics of athletics events is their direct relationship with determining physical capacity, such as speed and explosive strength in the 100-meter sprint and shot put, respectively. (MACKALA, 2015).

Borba et al. (2017) in their discussion states that most of the studies used in their research suggest post activation potentiation in different athletics events.

In this sense, it is possible that the performance of conditioning activities that induce PPA increase the acute performance in athletics events that require a great manifestation of muscular strength, such as the shot put event.

Therefore, the present study aims to evaluate the effects of conditioning activities of the lower and upper limbs on the performance of the shot put and thus infer how much the central and local mechanisms potentiate physical performance.

Methodology:

Sample

The sample consisted of 20 volunteers, 13 male volunteers, with an average age of 21.69 and an average mass of 74.23 and 7 female volunteers, with an average age of 21.71 and an average mass of 50.71, physically active with which they did not present injuries to the joints involved and did not complain of pain in the same period of 6 months prior to the collection.

Before the first session, all volunteers signed a free and informed consent form that explains the purpose of the research procedures, authorizing and enabling the progress of the research. The present study was approved by the research ethics committee of the State University of Minas Gerais under registration no. 1306982.

Data collection was carried out in the performance and human movement analysis laboratory and on the athletics track of the PUC - Minas / Coração Eucarístico sports complex.

Measurements:

Weight was measured with the volunteer barefoot, in the anatomical position on a Tech Line scale. To measure height, a tape measure was used. We use an excel spreadsheet (individual and collective) to file the collected data. Ortobom mat for female arm flexion. We used a 3M Crepe tape to mark each volunteer's 45° angle on the batten. To guide the volunteer about the pitch angle, we used 2 slats, attached to 1 wooden stick. to standardize the flexion, the volunteers used a shield at chest height, attached to an elastic band. The time of conditioning activities and intervals were recorded by 2 Chronometers VL 1809 (VOLLO). To perform the sitting throw, we standardized a chair with a backrest. To define the pitch angle, we used three devices: CARCI Goniometer; Squadron Souza; Sanny Flexometer. The official female Implement was used to carry out the shot puts of all volunteers. Throwing distance was measured using a 20M measuring tape. To perform the jumps and push-ups we used the official triple jump corridor and the official sandbox for the shot put.

Procedures:

The volunteers who committed themselves to the research, attended the research site four days to carry out the sessions, and there was an interval of 48 hours from one session to the other and they always appeared at the same time for the collection.

In this period of the 48-hour interval, the volunteer did not perform strenuous physical activities so as not to affect the research results, and the same before each session, they were not allowed to perform any type of stretching for any musculature. The volunteers received an external "stimulus" (motivation). The researchers during the sessions motivated the volunteers during the execution of each test.

Volunteers were instructed in all sessions to carry out conditioning activities with maximum effort.

In the first session, the volunteers performed an anthropometric assessment and then underwent a familiarization session with conditioning activities; arm flexion (FB) and vertical jump (SV), in addition to familiarization with the main activity, static shot put (APE).

Familiarization consists of two series of 10 seconds of arm flexion and vertical jumps, performing a maximum effort with a one-minute interval between each series. Six shot put attempts were performed with a 20-second interval between them. The order of execution of activities was FB-SV-APE in familiarization. The interval from the SV conditioning activity to the main EPA activity was three minutes in all sessions.

In the familiarization stage, the researchers adjusted the height of the batten for each volunteer, to standardize the shot put at 45° degrees, using specific devices, and marking each volunteer on the batten so that in all sessions the volunteers performed the throw at the same defined height.

In the FB exercise, the volunteer positioned himself in ventral decubitus to the ground, legs extended, supporting only the hands and toes on the ground, the women supported the knee on the mat, hands aligned a little ahead of the line of the shoulders and elbows extended, performs elbow flexion followed by vigorous extension of the same, (stretching / shortening cycle) so that the hands lose contact with the ground at the end of each elbow extension.



Figure 1: Arm Flexion.

In the SV exercise, the volunteer must stand with feet parallel at shoulder width, hands resting on the hips and then perform vigorous flexion and extension of the hips and knees so that the hip angle is 90° during the flexion of the hips. hips and knees, (stretching-shortening cycle) performing the vertical jump, followed by landing with slight bending of the knees in order to cushion the fall.

In the APE, the volunteers remained seated in a chair with a backrest, feet flat on the ground, holding the weight with both hands at chest height, resting their thumbs on the sternum, elbows high so as not to cause discomfort to the volunteer, and trunk resting on the chair. Without removing the torso from the chair and without losing contact with the feet with the ground, they must throw the weight with both hands, extending the elbows, and throwing the weight as



Figure 2: Vertical jump.



Figure 3: Shot put

far as possible above the 45° angle marked on the slat with the stick.

This form of throw was chosen because it is an educational practice among beginner and advanced athletes to learn and improve the shot put technique. In addition, the APE presents a technique that is easy to assimilate and learn by beginners. And the number of repetitions was standardized by the fact that in the official test of the modality the athlete is entitled to six shot put attempts.

In the second, third and fourth meeting, the volunteers participated in the sessions randomly: A) Control (CON), in which there was no conditioning activity before the APE; B) FB followed by APE; C) SCM followed by APE. The interval between the conditioning activity and the main activity was three minutes. Two series of 10 seconds were performed for each type of conditioning activity with an interval of one

minute between them and six attempts for the shot put, with an interval of 20 seconds between them.

Statistical analysis:

Data were presented as mean and standard deviation (SD). Data normality was guaranteed after performing the Shapiro-Wilk test. One-way ANOVA with repeated measures was used to compare the distance of the best shot between situations. The significance level adopted was less than 5%. In addition, the individual response of the volunteers to the interventions was evaluated using the typical error^{14,20}. According to these authors, the average and SD of the performance of each volunteer were calculated, taking into account the six throws of the control session. The positive effect of AC was considered when the volunteer's performance was 1.5 x SD greater than the average. When the subject's performance was 1.5 x SD less than the mean, the effect of AC was considered negative. Finally, if the performance on pitches was within ± 1.5 x SD of the mean, he was considered non-responsive to AC.

Results

Figure 4 shows the result of the distance of the best shot between the experimental situations. The one-way ANOVA did not indicate statistical difference between the control situations (3.11 ± 0.75 m), push-up (3.19 ± 0.99 m) and vertical jump (3.12 ± 0.80 m).

The individual analysis using the typical error indicated a prevalence of the conditioning activity arm flexion over the conditioning activity vertical jumps. As can be seen in Table 1, there were seven positive responses for AC arm flexion and five for AC vertical jumps in men. Women responded less to ACs, with only one positive response to

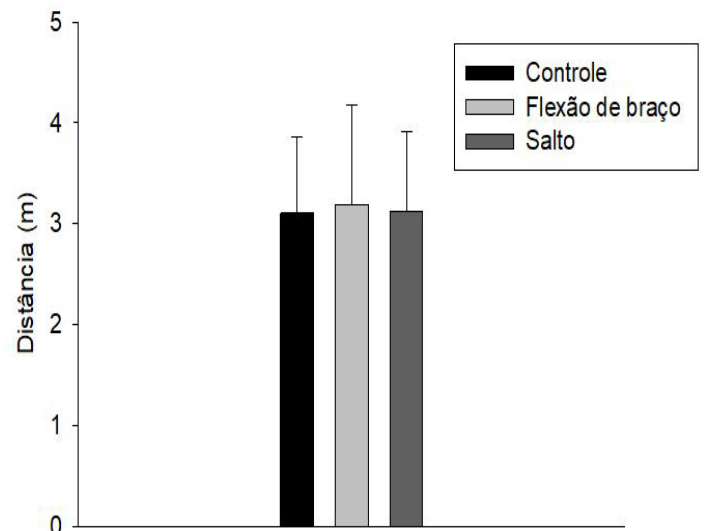


Figure 4: Mean and standard deviation of throwing distance between situations. $F=0.49$; $p=0.6$.

Table 1: Individual responses to conditioning activity protocols.

Volunteers	FB arm flexion	SV Vertical Heels	Strength training
Men (n=13)			
V1	+	+	Yes
V2	+	-	Yes
V3	+	-	Yes
V4	+	+	Yes
V5	+	+	Yes
V6	-	-	No
V7	-	-	No
V8	-	=	Yes
V9	=	=	No
V10	-	-	No
V11	=	-	No
V12	+	+	Yes
V13	+	+	Yes
Women (n=7)			
V1	-	=	Yes
V2	-	+	Yes
V3	-	-	No
V4	+	+	Yes
V5	=	-	Yes
V6	-	-	No
V7	-	+	Yes

AC arm flexion and three to AC vertical jumps.

It was still possible to observe that of all the men who perform strength training for about 6 months, only one did not show positive results in at least one conditioning activity.

In relation to the women, it is possible to perceive that the two volunteers who have not performed strength training for about 6 months had negative results for the two conditioning activities.

Discussion

Evaluating the effect of ACs is a concern of scientists, physical trainers and technicians, since they are performed before different types of main activity, ranging from leisure activities to high performance. The CAs are also performed by subjects with different levels of training, from sedentary to athletes.

Therefore, the present study sought to evaluate the central and local mechanisms of potentiation of physical performance through conditioning activities of upper and lower limbs. Thus, seeking to know which mechanism of potentialization of physical performance brings more significant results and if the exercises of arm flexion and jumping against movements present significant values to trigger the potentialization.

It was possible to observe that there was no statistical difference between the control situations, arm flexion

and vertical jumps and that there was not a predominant mechanism to trigger the APP in this study. However, in an individual comparison by typical error, it was possible to identify that some volunteers responded positively to the ACs.

Recent studies report that maximal voluntary contractions of the lower limbs can improve explosive strength and power in jumps and sprints. In addition, improved performance in throwing and releases were also found. Terzis et al. (2012) found improvement in throwing performance 1 min after three counter movement jumps in experienced throwers (without AC= 15.45± 2.36 m, with AC= 15.85±2.41 m; p= 0.0003).

Evetovich et al (2015) also found an increase in throwing distance (without AC= 11.77±1.81; with AC= 11.91±1.81 m; p ≤ 0.05) in university athletes of both sexes 5 min after three maximum repetitions in the bench press with bar.

Karampatsos et al (2013). found greater distance in hammer throw 1 min after three jumps with counter movement (Pre= 62.92±4.43 m vs. Post 64.42±5.13 m; p= 0.047) and 1 min after 20 m sprint (Pre= 64.87±3.90 m vs. Post = 65.30±4.02 m, p= 0.013) in experienced male throwers. Similarly, the results of the present study suggest that maximal muscle actions of the upper limbs lead to an acute improvement in shot put in beginner subjects.

Therefore, it is possible to say from the results found, that individuals who perform strength training are more apt to be potentiated, we believe that for this reason there was no significant difference in the averages of the general results, since the research had active volunteers physically and not that perform continuous strength training.

It was possible to identify that volunteers who do not practice strength training in bodybuilding showed negative results in at least one of the conditioning activities. Among the volunteers, they presented several physical activities, which may have affected their performance in each particular session of the research.

Therefore, we suggest a continuation of the study with a standardization of the sample, where all volunteers are practitioners at least of strength training in bodybuilding, thus, seeking to know which of the mechanisms is responsible for the development of APP.

Conclusion

The results of the present study suggest that there is no predominance of central or local mechanisms in triggering APP. However, there was an effect of conditioning activities on throwing performance.

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Term of Free and Informed Consent

Study title: Effect of upper and lower limb conditioning activities on shot put performance.

Responsible researchers: Diego de Alcântara Borba, Jefferson de Souza Epifanio, João Gabriel dos Santos Monteiro Nunes, José Mauro Vidigal.

Institution/Department: Pontifical Catholic University of Minas Gerais/Institute of Biological and Health Sciences - ICBS – Belo Horizonte

Research objective: The present study aims to evaluate the effects of conditioning activities of the lower and upper limbs on the performance of the shot put and thus infer how much the central and local mechanisms of potentialization of physical performance..

Procedures: We hereby invite you to participate as a volunteer in this research that will be carried out at the Pontifical Catholic University of Minas Gerais, located at Avenida Dom José Gaspar, 500, Coração Eucarístico, Belo Horizonte. Initially you will be informed about the objectives, procedures related to the research. You will participate in a group of volunteers who will carry out the activities) familiarization, data collection with conditioning activity of vertical jumps, arm flexion on the ground and control activity and in all of them static shot put will be performed. The activities will be carried out two to three times a week in the afternoon and evening, lasting approximately 5 to 15 minutes per session. The individual collection of each volunteer will last four days and the activities will be carried out on the athletics track and in the laboratory of the PUC MINAS Sports Complex.

Risks: Your participation in this research implies risks in the practice of jumping and flexion. The risks are the same as those presented during an activity supervised by a Physical Education professional, such as, for example, during physical education classes.

The information collected will be confidential and known only to the responsible researchers. Volunteers will not be identified at any time, even after disclosure of results. You will have access to the researchers at any time to clarify any doubts or withdraw this consent and stop participating in the study without any prejudice to you and the author. There will be no financial compensation related to your participation. Before agreeing to participate in the research and signing this term, researchers must answer all your questions. This TCLE will be made in two copies, one for you and another for the researcher.