Bench press exercise performed as conditioning activity improves shot put performance in untrained subjects

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Abstract — Aims: The aim of the present study was to evaluate the effect of bench press exercise performed as conditioning activity on the shot put performance in untrained subjects. Methods: Twelve healthy men (26 ± 6 years; 1.8 ± 0.1 m; 73.5 ± 10.4 kg; 13.2 ± 5.2% body fat), with no experience in shot put, were randomly assigned into two conditions: 1) Control: subjects performed six shot put attempts, and 2) Bench press exercise: subjects performed six shot put attempts 7 min post 2 sets of 5 repetitions maximum (RM) of bench press exercise. A metal ball of 4 kg was used for shot put attempts, and subjects were instructed to perform each shot put according to the static shot put technique. Results: Shot put performance was greater after bench press condition when compared with control condition (8.2 ± 1.2 m vs. 7.8 ± 0.8 m, respectively, p < 0.05). In addition, eight out of 12 volunteers positively responded to the conditioning activity. Conclusion: The results suggest that bench press exercise performed as a conditioning activity improves shot put performance in untrained subjects. Moreover, the conditioning activity should be individually set.

Keywords: athletics; post-activation potentiation; preparatory activity.

Introduction

Athletes use to perform conditioning activities (CA) before training or competition in the expectation that such activities lead to performance improvement. Indeed, it has been suggested that strength or power exercises performed as CA can improve physical performance. This transient potentiation effect of conditioning activities on performance is caused by physiological changes called post-activation potentiation (PAP). The main alterations triggered by the strength or power CA are an increase on motor units recruitment, improvement of synchronization and conduction velocity of nerve impulses, inhibition of antagonist muscles, enhancement in the interaction mechanism of cross-bridge formation and an increase of cytosolic Ca2+ concentration. Such changes would allow more coordinated and faster movements. Thus, athletes from sports modalities that require high strength, power and speed can benefit from PAP induced by CA. Terzis, Karampatos, Kyriazis, Kavouras, Georgiadis found an improvement of shot put performance 1 min after 3 countermovement jumps in experienced shot putters. Evetovich, Conley, McCawley also found an increase on shot put distance 5 min after 3 repetitions maximum (RM) of bench press exercise. An important aspect to be highlighted is that both studies evaluated athletes. To the best of our knowledge, no study has evaluated the effect of bench press exercise performed as CA on shot put performance in untrained men. The evaluation of this issue could be important from a practical standpoint since muscular strength is a physical capacity that can limit performance and learning of shot put.

In addition, to date, studies investigating the effects of CA on shot put performance have not taken into account the individual responses to CA reducing its practical applicability. As described above, the PAP depends on the individual characteristics. Thus, it seems more appropriate to evaluate the effects of PAP protocols individually, since in the same group there may be subjects responding positively and others not. Therefore, the aim of the current study was to evaluate the effect of bench press exercise performed as conditioning activity on shot put performance in untrained subjects. Based on the PAP mechanisms, it was hypothesized that bench press exercise would lead to greater shot put performance.

Methods

Subjects

The sample size was determined using the GPower software (version 3.1.2; Franz Faul, Universitat Kiel, Germany), considering the following specifications: family test = t-test, statistical test = difference between two dependent means (matched pairs), tails = two, $d$ effect size = 0.9, $\alpha = 0.05$, power $(1-\beta) = 0.8$. Twelve untrained men (age: 26 ± 6 years; height: 1.8 ± 0.1 m; body weight: 73.5 ± 10.4 kg; body fat: 13.2 ± 5.2%) volunteered for this study. The inclusion criteria were subjects: a) between 18 and 40 years, b) who accomplished all technical requirements of the static shot put, c) with at least six months of experience with bench press exercise, and d) who answered no to all questions of the Par-Q physical activity readiness.
questionnaire. All subjects were informed of the procedures and risks before giving written informed consent to participate in the study. Approval for study procedures was obtained from The Research Ethics Committee of the State University of Minas Gerais (1.306.982). The procedures respected the research resolution with human of the National Health Council, Brazil.

Experimental design

Two to three days prior the beginning of the experimental conditions, volunteers attended the laboratory on two occasions for study procedures familiarization and for physical characteristics measurement. To evaluate the effect of the bench press exercise on the shot put performance, volunteers performed six attempts of a static shot put 7 min following each of the two conditioning protocols, in a randomized and balanced fashion, 2 to 3 days separating each condition. The conditioning activities were: 1) Control (CON) - subjects performed no conditioning activity; 2) Bench press (BP) - subjects performed 2 sets of 5 RM of bench press exercise. All visits took place at the same time of the day to minimize the circadian effects. The subjects were instructed to maintain their normal daily activities, but they were asked not to perform strenuous exercise 24 h before each visit. In addition, they were instructed not to take caffeine, supplements, and alcohol during the study period.

Familiarization sessions

Each familiarization session consisted of 4 sets of the 10 shot put (implement of 4 kg). In order to facilitate the learning of static shot put technique, the first set of the first familiarization session was preceded by 10 throws using a ball of 400 g, which contained the same circumference of the official implement. At the end of the second familiarization session subjects had to accomplish all technical requirements of the static shot put, which were: a) the implement kept in the palm of the hand, pressed against the neck and below the ear, elbow abducted and kept away from the trunk, trunk slightly rotated laterally, with feet shoulder width apart; b) hip and trunk rotation before the onset of arm movement, and c) elbow extension of the throwing arm, keeping the elbow high and thumb down, extension of the ankles, knees, and trunk at the end of the throw. They were considered able to continue in the study when they carried out at least four attempts consecutively according to the technical requirements of the static shot put. The volunteers received verbal instruction and demonstration of the correct static shot put technique whenever necessary. The static shot put was chosen in order to minimize the lower limbs involvement. In addition, this technique consists of fast assimilation and easy learning for novice subjects.

Anthropometrics measurements

Body mass and height were measured using a stadiometer (Welmy®, Santa Bárbara D’Oeste, SP, Brazil). The skin folds of the triceps, pectoral, subscapular, subaxilla, abdominal, suprailiac and mid-thigh were measured using a plicometer (Cescorf®, Porto Alegre, RS, Brazil), and body fat were estimated according to the Jackson and Pollock.

5 RM test

The load of the BP protocol was determined by the 5 RM test according to Baechle and Earle. Volunteers warmed-up by performing 1 min of free dynamic stretching. Then, the 5 RM load was achieved with no more than six attempts with 3 min of rest between attempts. A load was adjusted with weight plates starting at 1 kg. The test was interrupted when the subject reached concentric failure. Subjects returned to the laboratory 2 h later to perform the 5 RM retest. Test-retest reliability coefficient (intraclass correlation coefficient [ICC]) was 0.99.

Conditioning activity protocols

Prior the experimental conditions, the volunteers warmed-up by cycling for 5 min on a cycle ergometer (Maxx Pro®, Indaiatuba, SP, Brazil) with a cadence of 80 rpm and a load of 0.5 kg, followed by 1 min of upper-body dynamic stretching. For the control protocol, the subjects performed no conditioning activity. The BP protocol consisted of 2 sets of 5 RM of bench press exercise and 3 min of rest between the sets. The same investigator conducted all conditioning activity procedures.

Shot put performance assessment

Shot put performance was measured by using a millimeter tape. The zero ends of the tape was placed at the nearest mark made in the ground, and then the tape was pulled through to the center of the circle. The shot put performance was considered the distance from the closest mark made by the implement up to the point where the tape crosses the inside edge of the circumference of the circle. The volunteers performed six throws 7 min after each conditioning protocols using a metal ball of 4 kg. It was given 1 min of rest between each throw. The throw with the longest distance was considered for statistical analysis.

Statistical analyses

Distribution normality and homogeneity of the data were initially assessed by using the Shapiro-Wilk and Levene’s tests, respectively. Data were expressed as the mean ± standard deviation, and the level of significance adopted for all analyses was $P < 0.05$. The paired t-test was used to compare the distance of the best throw between both CON and BP conditions. Cohen’s $d$ effect size was calculated from the difference between the CON and BP conditions divided by the pooled standard deviation to examine the magnitude of conditioning activity effect. The obtained $d$ values were used to define trivial ($d < 0.2$), small ($0.2 < d < 0.5$), medium ($0.5 < d < 0.8$) and large ($d > 0.8$) effect sizes. In addition,
individual responses were assessed by taking into account a threshold of 1.5 times the typical error\textsuperscript{14,20}. Subjects who had shot put performance greater and lower than 1.5 times typical error were considered positive and negative responders, respectively\textsuperscript{14}. Finally, if throws performance were within 1.5 times the typical error, the subject was considered nonresponder\textsuperscript{14}.

### Results

Shot put performance was higher after the BP protocol (8.2 ± 1.2 m) when compared to the CON protocol (7.8 ± 0.8 m) ($t = 3.15$, $p = 0.009$; power = 0.8, $d = 0.4$, Figure 1).

Figure 2 shows the individual responses to BP protocol. Eight volunteers were positive responders (A-H), one was a negative responder (I) and three were considered non-responders (J-L).

![Figure 1. Mean ± SD of the shot put CON and PB situation.\(*\) p< 0.05, maior que CON.](image)

![Figure 2. Individual response to the BP protocol. Each point represents a throw. Throws above the upper dashed line represent improved performance while throws below the lower dashed line represent performance worsening. Throws between dashed lines shows that there was no response to CA.](image)

### Discussion

Assessing the effect of CA is of interest for coaches, and strength and conditioning trainers, since it is performed before various types of main exercises, ranging from leisure to high-performance exercises. CA is also performed by subjects from different levels of training, from untrained subjects to athletes. Thus, the present study aimed to evaluate the effect of bench press exercise performed as conditioning activity on shot put performance in untrained subjects. It was observed an improvement of 5.13 % in the shot put performance in untrained subjects 7 min post 2 sets of 5 RM bench press exercise. Additionally, there was an individualized response to BP protocol. This result may be attributed to the mechanisms of PAP\textsuperscript{4,5,7}, since muscle strength may be enhanced to post a maximal voluntary contraction.

Angle and velocity of implement release are the main biomechanical parameters that affect shot put performance\textsuperscript{21,22}. These both parameters are determined mainly by the rear-knee extension\textsuperscript{23}. Certainly, the greater the strength and power produced on rear-knee, greater the force transferred to hip rotation and then to shot put release\textsuperscript{23}. The BP protocol evaluated in the current
is a suitable CA to activate PAP mechanisms and improve shot
caused a small effect (\(d = 0.4\)) on the shot put performance. To date, it
is unclear why CA does not benefit some individuals. Some hypotheses may emerge from the findings of the present study.
One is that performing a CA can result in fatigue. According to
Rassier and Macintosh\(^{34}\), the balance between the PAP and fatigue
mechanisms determines the performance of a main activity. If
there is an imbalance in favor of fatigue, muscle performance will
be impaired. On the other hand, if the imbalance is in favor of
PAP mechanisms, performance will increase. Taking into account
that the sample of the present study was composed of untrained,
with different fitness levels and that CA and rest before the main
activity were the same for all subjects, it is possible that fatigue
overlapped the PAP mechanisms in those subjects who did not
present a positive response to AC. Another factor that may explain
the individual responses to CA is the predominance of the motor
unit type. Previous studies have shown a greater PAP in subjects
with higher percentage of type II fibers, indicating that this type
of motor unit is more susceptible to PAP\(^{35,36}\). Individual responses
to CA suggest that the prescription of CA must be individualized.
In addition, the present study is not without limitations.
The mechanisms associated with PAP were not evaluated. Thus,
future researches should investigate the physiological changes linked to bench press protocol. In addition, as previously
described, CA potentiating effects are more pronounced in trained
subjects. Due to the small availability of this population, the
present study investigated untrained subjects, which would not
be the ideal to evaluate the PAP phenomenon, due to the strength
and technique variability among this subjects\(^{32}\). On the other
hand, the typical error analysis used in the preset study allowed
minimizing the individual effects in PAP triggering.

Conclusion
The results of the present study suggest that untrained subjects
can increase shot put performance 7 min post bench press exercise.
Considering that not all subjects profit from CA, it is suggested that
the CA should be individually set. Future studies should evaluate the effect of other conditioning activities on shot put
performance (i.e., conditioning activities involving lower limbs),
as well as other athletic modalities. In addition, other populations
should be investigated, such as adolescents, women, and athletes.

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