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Considering the Effects of Upper Body, Lower Body, and Their Combination on Post-Activation Performance Enhancement of Bowling Velocity Among Amateur Cricket Players

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Abstract

Objectives. This study aimed to investigate the effects of post-activation performance enhancement on bowling velocity among amateur cricket players using multiple interventions as conditioning activities focusing on the upper body, lower body, and a combination of both.

Materials and methods. Eight amateur cricket bowlers were recruited for the study and, in a randomized crossover manner, allocated to conditioning activities aimed at the upper body (i.e., 10 pull-ups + 6 wall ball slams), lower body (i.e., 10 air squats + 6 broad jumps), or both (5 pull-ups + 3 wall ball slams combined with 5 air squats + 3 broad jumps). The bowling velocity was measured at baseline and after one minute and four minutes of completing the intervention.

Results. The findings indicate no significant improvement ($p = 0.939$) in ball velocity compared to the control condition after the three experimental conditions. However, post-hoc results showed a substantial decrease in bowling velocity after one minute.

Conclusions. In conclusion, conditioning activities using pull-ups and wall ball slams for the upper body, air squats, and broad jumps for the lower body, or their combination, do not induce post-activation performance enhancement during cricket bowling.

Keywords: post-activation potentiation, speed, athletic performance, plyometric exercise.

Introduction

Cricket is a sport played between two teams, with one team bowling and the other team batting (Bartlett, 2003; Noakes & Durandt, 2000). The batting team aims to score as many runs as possible, whilst the bowling team aims to minimize the runs scored. During the match, one player from the bowling team delivers the ball to the batting team at varying speeds and/or spin (i.e., fast bowlers and spin bowlers). The fast bowlers aim to deliver the ball to the batsman at the highest possible velocity. Thus, it is of paramount importance for a fast bowler to achieve the maximal velocity of the ball delivery (Noakes & Durandt, 2000).

The physical performance of athletes can be increased via different training strategies on a long-term or short-term basis. One such strategy to induce acute improvement in physical performance is post-activation performance enhancement (PAPE) (Blazevich & Babault, 2019). The PAPE is characterized by a short-term enhancement in performance (e.g., strength) subsequent to a conditioning exercise. Mechanistically, PAPE is suggested to be associated with post-activation potentiation occurring approximately 28 seconds after the conditioning exercise (Blazevich & Babault, 2019; Hodgson et al., 2005). This phenomenon involves heightened phosphorylation of myosin regulatory light chains, increased recruit-

ment of fast-twitch motor units, and various factors contributing to its duration, including elevated muscle temperature, intramuscular fluid accumulation (e.g., muscle blood flow and water), decreased muscle pH, and heightened neural drive (i.e., increased muscle activation) (Blazevich & Babault, 2019). However, for the optimization of PAPE's efficacy, conditioning exercises should be tailored to target specific aspects of performance improvement. Additionally, since both performance enhancement and fatigue can co-exist following PAPE-inducing conditioning exercises, careful consideration of the timing, particularly the rest interval between the application of PAPE-inducing stimuli and the subsequent competitive or performance activity, is crucial to prevent fatigue from overshadowing the potentiation effects (Chen et al., 2024).

Positive effects of PAPE using various exercises as conditioning activities have been observed across various sports activities and skills (Esformes et al., 2011; Gossen & Sale, 2000; Vargas-Molina et al., 2021). In addition, in a recent meta-analysis the authors reported ballistic jump exercises induced PAPE during jumping and sprinting (Ulloa-Sánchez et al., 2024). Moreover, recently, researchers have also studied the effects of different conditioning activities in inducing PAPE during sports-specific performance (e.g., using a combination of ballistic jumps to improve judo-specific performance) (Baruah et al., 2024). Furthermore, using ballistic throws as a conditioning activity has also been reported to induce PAPE for upper-body throwing performance after 3 minutes of recovery (Finlay et al., 2022). However, there are no researchers who studied the effects of conditioning activities on the PAPE of bowling velocity of cricket bowlers. Specifically, whether PAPE can be achieved using the upper body, lower body, or their combination to improve the ball velocity during cricket bowling among pace bowlers has not yet been studied. Therefore, this study aimed at comparing the effects of upper-body, lower-body, or their combination in improving the ball velocity during cricket bowling among pace bowlers.

Materials and Methods

Participants

Eleven collegiate-level male cricket bowlers were initially recruited for the study. However, only 8 participants (aged: 19.3 ± 1.2 yrs., height: 170.8 ± 3.0 cm; body mass: 67.1 ±3 .5 kgs) completed the study. All the participants had a minimum of five years of training experience in cricket. The participants were actively practicing the sport during the data collection. The inclusion criteria required participants to (1) be male, (2) have a minimum of one year of resistance training experience, (3) be adult, and (4) be injury-free with no major injuries in the past 6 months. The participants were explained the details of the study and the risks associated with the study. Thereafter, the participants signed informed consent forms. The study was approved by the Internal Review Board of the School of Physical Education and Sports, Rashtriya Rakhsa University (approval number: RRU/SPES/EEF/FMR/139, dated 21/12/2023), and conducted according to principles in the updated declaration of Helsinki.

Experimental Design

The study utilized a randomized cross-over design. Participants completed two familiarization sessions to avoid the learning effects and four actual experimental sessions to examine the effects of the conditioning activities on ball velocity during medium pace bowling. During the familiarization sessions, the anthropometric characteristics were recorded. In the experimental sessions, the baseline data were recorded which was followed by the warm-up. The control group performed the warm-up, whereas the experimental group replaced some parts of the warm-up with the conditioning exercises.

Conditioning Protocols

The conditioning protocols used in the study are presented in Table 1. The conditioning activities were performed based on contrast training format, i.e., exercise 1 followed by exercise 2, in a set-by-set fashion (Thapa et al., 2021). A total of 3 sets were performed. For combined, the upper body exercise sets were completed first followed by lower body exercise sets.

Table 1. Conditioning protocol

	Exercise 1	Repetitions	Exercise 2	Repetitions
Upper-body	Pull-ups	10	Wall ball slams	6
Lower-body	Air Squats	10	Broad jumps	6
Combined	Pull-ups	5	Wall ball slams	3
	Air squats	5	Broad jumps	3

Note: Three sets were performed

Data Collection

A reliable (Makar et al., 2024) radar gun (Bushnell Velocity Gun Model# 101911, Overland Park, Kansas 66214) having a tracking history with a Ball of 16-177 km/hr at 27 meters with accuracy: ± 1.6 km/hr was used to quantify the pace bowling velocity in cricket: baseline, one minute after the conditioning activities, and four minutes after the conditioning activities. The height of the radar gun was kept consistent across the testing sessions and placed at the bowler's end. As the first point of reference, the baseline measurement reflected the bowler's natural pace before any external interventions were applied. In order to assess any PAPE effects of the interventions on bowling velocity, measurements were taken at one and four minutes after the intervention.

Statistical Analysis

Data are presented as means and standard deviations. The normality of the data was verified using the Shapiro-Wilk normality test. A four (conditions: control, upper body conditioning, lower body conditioning, combined conditioning) by three (time: baseline, one-minute, four-minute) repeated measures ANOVA was used to identify the effect of conditioning activities on bowling velocity. Post-hoc tests were conducted using t-tests with Bonferroni corrections. The statistical significance was set at p-values of ≤ 0.05.

Results

The means and standard deviations at baseline, post-one-minute, and post-four-minute are presented in Table 2. No significant condition × time was observed ($p = 0.939$).

Table 2. Mean and standard deviation of ball velocity

Variables	Control	Upper body	Lower body	Combined
	Mean (standard deviation)			
Baseline (km/hr)	101.8 (3.4)	101.8 (3.4)	101.8 (3.4)	101.8 (3.4)
Post-one-min (km/hr)	100.3 (4.5)	98.3 (2.4)*	98.9 (2.7)*	98.4 (2.8)*
Post-four-min (km/hr)	102.8 (5.6)	101.1 (4.1)	101.3 (4.1)	101.8 (5.2)
P value (condition × time)	0.939			

Note: * significant difference with baseline

However, post-hoc analyses showed a significant decrease in the ball velocity post one minute after all three conditioning activities.

Discussion

The study aimed to investigate the PAPE effects of conditioning activity using upper body exercise, lower body exercise or their combination on the ball velocity of amateur-level medium-pace bowlers in cricket. The findings suggest a significant decrease in ball velocity after one minute but no difference after four minutes of performing the conditioning activities.

The significant decrease in ball velocity after one minute of conditioning activities may be due to the fatigue associated with the conditioning activities (Hodgson et al., 2005). The balance between the PAPE and fatigue is important in order to observe the phosphorylation of myosin regulatory light chains and recruit higher-order motor units (Blazevich & Babault, 2019). Therefore, it is plausible that a one-minute recovery was insufficient in minimizing the effect of fatigue on the ball velocity. However, although previous studies have suggested that PAPE can be achieved at a shorter duration with ballistic conditioning activities (Seitz & Haff, 2016; Thapa et al., 2020), there are various moderating factors associated with PAPE (e.g., relative strength, training experience) (Blazevich & Babault, 2019). Of note, the participants involved in the current study were amateur-level cricketers, which may have reduced the effect of the conditioning activities since the strength level of the participants moderates the PAPE effects (Blazevich & Babault, 2019; Seitz & Haff, 2016). However, no previous study has researched the effects of conditioning activities on cricket bowling velocity; hence, a direct comparison is not possible. Although not in cricket, these findings align with a previous study conducted on baseball athlete's pitching velocity (Carrier, 2019). Carrier (2019) reported that conditioning activities using ballistic medicine ball throws did not significantly affect baseball pitching velocity one minute after the application of the conditioning activity in collegiate-level baseball athletes.

Furthermore, after four minutes of the conditioning activities, the ball velocity returned to a similar level as the baseline values. It may be possible that the fatigue due to the conditioning activities started diminishing with a longer recovery (Blazevich & Babault, 2019). Of note, in the current study, the authors did not collect data beyond four minutes recovery duration, and in several PAPE studies, it has been suggested that an optimal window for the PAPE effect after a heavy-load conditioning activity is a beyond four-minute duration (e.g., 8-12 minutes) (Esformes et al., 2011; Finlay et al., 2022). Therefore, future research should study the effects of various ballistic conditioning activities (e.g., using elastic bands) on enhancing bowling velocity beyond a four-minute duration (e.g., eight minutes) in cricketers from various competitive level.

There are a few limitations in the study that should be acknowledged. Firstly, the authors could recruit only 8 participants for the study. Due to the study's demand to recruit only amateur medium-pace bowlers, the authors could reach this current sample size threshold. Secondly, only male bowlers were included in the study. Therefore, the results of this study should not be extrapolated to female bowlers. Thirdly, based on previous literature on using ballistic conditioning activities to induce PAPE (Seitz & Haff, 2016), the recovery duration chosen for PAPE was 1-minute and 4-minute time-point. However, the current findings necessitate the need for studies with longer recovery duration (e.g., 8 minutes). Furthermore, previous studies have used heavy-load resistance exercises to evoke the PAPE effect across different athletic movements (e.g., jumps, sprints). Therefore, future research should also use high-intensity resistance exercises to study the effects on PAPE on different physical aspects of a cricket bowler.

Conclusion

In conclusion, no PAPE effects were observed using the upper body, lower body, or their combination in ball velocity among amateur male medium-pace bowlers. Of note, a negative effect on bowling performance was observed after 1 minute of recovery, suggesting a complex relationship between potentiation and fatigue.

Conflicts of interest

We declare that there are no conflicts of interest.

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Розгляд впливу системи силових вправ, призначених для розвитку верхнього, нижнього відділів тіла та їхнього поєднання на постактиваційне підвищення результативності показників швидкості виконання боулінгу серед гравців-аматорів у крикет

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Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 5 с., 2 табл., 21 джерело.

Мета дослідження. Мета цього дослідження полягала у вивченні впливу постактиваційного підвищення результативності на показники швидкості виконання боулінгу (дії, спрямовані на просування м'яча до воріт) серед гравців-аматорів у крикет, використовуючи кілька інтервенцій у вигляді кондиціонуючих вправ, спрямованих на розвиток верхнього та нижнього відділів тіла, а також поєднання зазначених типів тренувань.

Матеріали та методи. Для проведення дослідження було відібрано вісім гравців-аматорів у крикет, яких розподілили за методом рандомізованого перехресного типу з метою виконання кондиціонуючих вправ, спрямованих на розвиток верхнього відділу тіла (10 підтягувань + 6 ударів м'ячем об стінку), нижнього відділу тіла (10 повітряних присідань — класичні присідання без використання додаткового обтяження (власна вага) + 6 стрибків у довжину з місця) або поєднання

обох видів тренувань (5 підтягувань + 3 удари м'ячем об стінку в комплексі із 5 повітряними присіданнями + 3 стрибками у довжину з місця). Вимірювання швидкості виконання боулінгу проводилося на початковому етапі дослідження, а також через одну хвилину та чотири хвилини після завершення інтервенції.

Результати. Отримані дані свідчать про відсутність значного покращення (p = 0,939) швидкості польоту м'яча порівняно із контрольним станом після виконання трьох експериментальних умов. Однак post-hoc результати показали суттєве зменшення швидкості виконання боулінгу через одну хвилину.

Висновки. Таким чином, кондиціонуючі вправи, що включають в себе виконання підтягувань і удари м'ячем об стінку для верхнього відділу тіла, а також повітряні присідання та стрибки у довжину з місця для нижнього відділу тіла, або комбінація вказаних видів тренувань, не сприяють постактиваційному підвищенню показників результативності під час виконання боулінгу в крикеті.

Ключові слова: постактиваційне потенціювання, швидкість, спортивна результативність, пліометричні вправи.

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