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# OPTIMIZING AGILITY THROUGH POST-ACTIVATION POTENTIATION: THERAPEUTIC AND PERFORMANCE APPLICATIONS IN SPORT AND REHABILITATION

[1] Viola Maria Colaco , [2] Dhaval Chivate , [3] Basavaraj Motimath

1st Author: VIOLA MARIA COLACO [1]

2nd Author: DHAVAL CHIVATE [2]

3rd Author: BASAVARAJ MOTIMATH [3]

**Abstract:** Post-activation potentiation (PAP) describes the acute enhancement of muscle performance following a high- or moderate-intensity conditioning activity (CA). This phenomenon has gained prominence in both athletic and rehabilitative domains for its ability to improve strength, power, and agility. Agility defined as a rapid, whole-body movement involving a change in velocity or direction in response to a stimulus is crucial in many sports. This review explores the therapeutic and practical relevance of PAP for agility performance, synthesizing evidence from recent studies to discuss physiological mechanisms, training variables, individual responses, and implementation strategies across competitive and clinical contexts.

**Keywords:** Post Activation Potentiation, Agility, Conditioning Activity, Rehabilitation, Performance Enhancement.

## INTRODUCTION

Agility plays a vital role in sports that demand frequent changes of direction, acceleration, and deceleration, such as soccer, basketball, handball, and martial arts. Enhancing agility not only boosts performance but may also help reduce injury risk. Traditionally employed in strength and conditioning, PAP has recently been explored as a method to acutely enhance agility by activating the neuromuscular system through high-intensity conditioning activities followed by short rest intervals. While PAP is well established in improving jumping and sprinting capabilities, its specific influence on agility, particularly change-of-direction (COD) speed, has garnered increasing interest.

## PHYSIOLOGICAL BASIS OF PAP

The mechanisms underlying PAP are complex and multifactorial. One primary mechanism is the phosphorylation of myosin regulatory light chains, which enhances actin-myosin interaction and increases calcium sensitivity, resulting in elevated force production. Additional contributing factors include improved recruitment of high-threshold motor units, better synchronization of motor unit firing, and acute modifications in muscle structure such as a reduction in pennation angle which collectively enhance the neuromuscular system's readiness to perform explosive movements. These physiological changes create a short-term potentiated state, ideal for optimizing performance during subsequent athletic tasks when appropriately timed. [8,9,10]

## PAP AND AGILITY PERFORMANCE

Research examining PAP's effect on agility has produced variable results depending on the type of protocol and target population. Escobar Hincapié et al. compared unilateral and bilateral PAP protocols and found improvements in agility for both, with unilateral movements showing a marginally superior effect. [3] Orjalo et al. tested the use of barbell hip thrusts at 85% of one-repetition maximum (1RM) as a conditioning activity and observed enhanced 505 COD test performance when tested 4 to 16 minutes after the CA, although improvements were not significantly greater than those from a control condition.[6] In contrast, Singh et al. found that a mini-band warm-up improved countermovement jump (CMJ) and strength but had no significant effect on agility, suggesting that lighter-load PAP protocols may be inadequate for producing meaningful gains in agility-specific neuromuscular responses. [2]

## CONDITIONING LOAD AND TIMING

The effectiveness of PAP is heavily influenced by the intensity and timing of the conditioning activity. Petisco et al. evaluated warm-up protocols at 60%, 80%, and 100% of 1RM and found that 80% 1RM yielded the most consistent improvements in agility, repeated sprint performance, and jump tests. Lower (60%) or maximal (100%) loads were less effective, likely due to either insufficient stimulus or excessive fatigue. [7] These findings are supported by Karakoç et al., who demonstrated that judokas performed better in agility and vertical jump tasks following an 80% load protocol compared to both standard warm-up and maximal loading routines. [5] Additionally, Okuno et al. reported improved repeated sprint performance in elite handball players following a high-load half-squat CA, supporting the use of PAP to enhance multidirectional speed in high-performance athletes. [1]

## INDIVIDUAL FACTORS INFLUENCING PAP

Individual characteristics such as strength level and overall physical fitness significantly affect the PAP response. Guerra et al. observed that athletes with higher fitness levels experienced more pronounced PAP benefits, particularly in CMJ performance five minutes post-CA. [4] Stronger athletes often require shorter recovery periods and display more robust potentiation responses. Conversely, less-trained individuals may need longer rest intervals and may not benefit as much from high-intensity protocols. These insights underscore the importance of tailoring PAP interventions to individual capacity and training history. [8]

## CHRONOBIOLOGICAL CONSIDERATIONS

Recent evidence indicates that the time of day can influence the effectiveness of PAP protocols. Karakoç et al. reported that both agility and vertical jump performance were better in the evening than in the morning, likely due to circadian rhythms affecting body temperature, neuromuscular excitability, and hormonal fluctuations. These findings suggest that scheduling PAP protocols to align with an athlete's physiological peak typically in the late afternoon or evening may enhance their effectiveness. [5]

## CLINICAL APPLICATIONS IN REHABILITATION

In addition to performance enhancement, PAP protocols hold therapeutic potential in rehabilitation settings. They can be used to restore neuromuscular function, promote motor unit activation, and minimize re-injury risk in athletes recovering from lower limb dysfunction. Singh et al. demonstrated that mini-band-induced PAP improved peak muscle torque and power without imposing excessive mechanical stress, making it a safe and accessible intervention for patients in the later stages of rehabilitation. Moderate-load PAP strategies can be safely adapted to suit clinical populations, serving as an effective bridge to return-to-sport activities. [2]

## PRACTICAL RECOMMENDATIONS

To successfully apply PAP for agility enhancement, key variables must be optimized. Recommended practices include using compound lower-body exercises such as squats or hip thrusts at 80–90% of 1RM and allowing rest periods of 4–8 minutes post-CA. Individual differences should guide protocol intensity and recovery durations. Stronger or more experienced athletes may benefit from higher intensities and shorter rest intervals, whereas less-trained individuals may require lighter loads and extended recovery. Furthermore, incorporating PAP into warm-up routines in the late afternoon or evening may maximize performance outcomes based on circadian factors.

## CONCLUSION

Post-activation potentiation offers a compelling, evidence-based approach to improving agility in both athletic and rehabilitative settings. When protocols are properly individualized and executed with the appropriate intensity and rest intervals, PAP can significantly enhance change-of-direction speed and explosive movement capabilities. Moderate-intensity protocols (~80% 1RM) have shown the most consistent benefits, especially among trained individuals. In clinical environments, PAP can serve as a low-risk, high-reward intervention for restoring neuromuscular readiness. As agility plays a critical role in performance and injury prevention, PAP represents a valuable tool for sports professionals and clinicians aiming to optimize functional movement and readiness.

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