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The Effect of Eccentric Based Post Activation Performance Enhancement Intervention Applied at Different Angular Velocities on Jump Performance (Preliminary Findings)

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Ethical Statement: It is declared that scientific and ethical principles have been followed while carrying out and writing this study and that all the sources used have been properly cited.

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Abstract

The aim of this study was to investigate the acute effects of eccentric contraction performed at different angular velocities (60°/s and 150°/s) on jump performance and to comparatively evaluate the contribution of eccentric loading at different velocities to the post activation performance enhancement (PAPE) effect. The study was completed in three sessions with 8 male participants. In the first session, anthropometric measurements, dominant leg determination, vertical jump test performance for the control condition and Familirization for eccentric contraction were performed. The next sessions were randomized at 48-hour intervals. In the second session, participants performed a single set of 5 repetitions (rep) maximal eccentric contractions at an angular velocity of 60°/s and after a 7-minute transition phase, vertical jump tests were performed. In the third session, participants performed a single set of 5 rep. maximal eccentric contractions at an angular velocity of 150°/s and after a 7-minute transition phase, vertical jump tests were performed. The results showed that two different angular velocities had no statistically significant effect on jumping performance ($p>0.05$). However, when compared with the control condition, 150°/s (+2.24 cm) has a higher delta value than 60°/s (+0.71 cm). As a result, especially eccentric contractions applied at higher angular velocity showed an increase in jump performance, indicating that angular velocity may be an important factor in the emergence of the PAPE effect (Cohen *d*: 0.56).

Keywords: Eccentric contraction, Angular velocity, Post-activation Performance Enhancement, Jumping.

Farklı Açısal Hızlarda Uygulanan Eksantrik Temelli Aktivasyon Sonrası Performans Arttırma Girişiminin Sıçrama Performansı Üzerine Etkisi (Ön bulgular)

Özet

Bu çalışmanın amacı, farklı açısal hızlarda (60°/s ve 150°/s) gerçekleştirilen eksantrik kasılmaların sıçrama performansı üzerine akut etkilerini araştırmak ve farklı hızlardaki eksantrik yüklenmenin aktivasyon sonrası performans arttırma (ASPA) etkisine katkısını karşılaştırmalı olarak değerlendirmektir. Çalışma 8 erkek

katılımcı ile üç seansta tamamlanmıştır. İlk seansta antropometrik ölçümler, dominant bacak belirleme, kontrol koşulu için dikey sıçrama test performansı ve eksantrik kasılma için familirizasyon gerçekleştirilmiştir. Sonraki oturumlar 48 saat aralıklarla rastgele şekilde gerçekleştirilmiştir. İkinci seansta katılımcılar 60°/s açısal hızda tek set 5 tekrar maksimal eksantrik kasılma gerçekleştirmiş ve 7 dakikalık bir geçiş fazının ardından dikey sıçrama testleri yapılmıştır. Üçüncü seansta, katılımcılar 150°/s açısal hızda tek set 5 tekrarlı maksimal eksantrik kasılma gerçekleştirmiş ve 7 dakikalık bir geçiş aşamasından sonra dikey sıçrama testleri yapılmıştır. Bulgular, iki farklı açısal hızın sıçrama performansı üzerinde istatistiksel olarak anlamlı bir etkisi olmadığını göstermiştir (p>0.05). Bununla birlikte, kontrol koşuluyla karşılaştırıldığında, 150°/s (+2,24 cm) 60°/s'den (+0,71 cm) daha yüksek bir delta değerine sahiptir. Sonuç olarak, özellikle daha yüksek açısal hızda uygulanan eksantrik temelli kasılmaların sıçrama performansında artış göstermesi, açısal hızın ASPA etkisinin ortaya çıkmasında önemli bir faktör olabileceğini göstermektedir (Cohen d: 0,56).

Anahtar Kelimeler: Eksantrik Kasılma, Açısal Hız, Aktivasyon Sonrası Performans Arttırma Sıçrama

INTRODUCTION

Jump performance, as one of the main parameters of explosive power production, is a critical component that directly affects success in many sports branches (1). Therefore, acute interventions to improve jumping have an important place in improving performance (2, 3). Short-term activation protocols applied before training are becoming prominent among strategies that aim to temporarily improve performance, especially in high intensity motor tasks (4) such as jumping (5). One of these strategies, post activation performance enhancement (PAPE), is characterized by short-term performance enhancement following heavy muscle activity (6).

The preferred muscle activation methods play a significant role in the occurrence of the PAPE effect. Generally, high intensity loading based on 1RM % (7) and plyometric exercises (8) are used for this purpose. However, in recent years, the potential of eccentric contractions (ECC) in particular has come to the forefront due to their high force production and neuromuscular stimulation capacity (9). ECC contractions involve the active extension of muscle tissue against an external force or load (10). Furthermore, several features and acute physiological responses specific to ECC contractions contribute to the generation of specific adaptive signals (e.g. fast-twitch muscle fiber hypertrophy, increased type IIx fiber composition) in the neuromuscular system (11). These adaptations are generally thought to reflect a transition to a faster and more explosive muscle phenotype (12).

ECC loading can be applied using different angular velocities, which directly affect the magnitude and nature of the physiological response. Lower angular velocities are often associated with higher torque production, whereas higher angular velocities are thought to promote increased neuromuscular recruitment, muscle-tendon stiffness, and rapid force development (11). Such applications are particularly relevant in sports where explosive activities like sprinting, jumping, and changing direction are frequent, including track and field, basketball, and football (13). Moreover, eccentric contractions are implemented in a variety of exercise modalities such as squats or eccentric leg press training (14, 15).

However, the magnitude of this effect produced by ECC can change depending on the angular velocity applied (16). In fact, loading at different angular velocities can have different physiological effects on performance output. Therefore, the aim of this study was to examine the acute effects of ECC performed at different angular velocities (60°/s and 150°/s) on jump performance and to comparatively evaluate the contribution of eccentric loading at different angular velocities to the PAPE effect.

METHOD

Experimental Approach to the Problem

In this study, subjects participated randomized in three experimental sessions. All interventions were conducted at the same time of the day (10:00-12:00). In the first session, anthropometric measurements, dominant leg determination, vertical jump test performance for the control condition and familirization for eccentric contraction were performed. The next sessions were randomized at 48-hour intervals. In the second session, participants performed a single set of 5 repetitions (rep) maximal eccentric contractions at an angular velocity of 60°/s and after a 7-minute transition phase, vertical jump tests were performed. In the third session, participants performed a single set of 5 rep. maximal eccentric contractions at an angular velocity of 150°/s and after a 7-minute transition phase, vertical jump tests were performed (Figure 1).

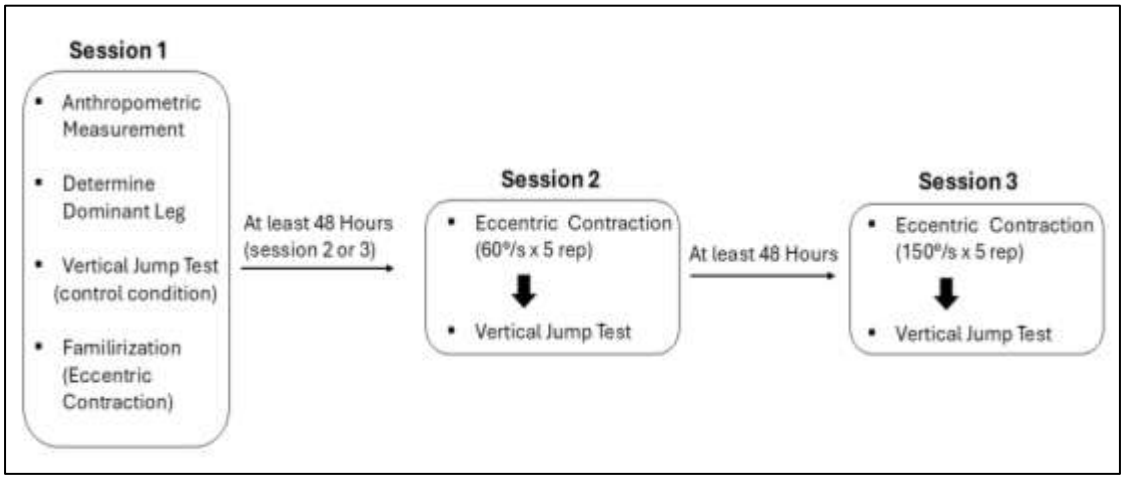


Figure 1. Experimental Design.

Subjects

The study included 8 male (age;22.37±3.62 years, height;179±5.6 cm, weight:85.01±21.36 kg, Training age;7±2 years) who were actively training. Subjects had a minimum of 5 years of resistance training experience, were actively training, and had no known neuromuscular disorders. Subjects with recently lower limb injuries, surgeries (within the last 6 months), or any musculoskeletal condition that might restrict eccentric exercise performance were excluded. As this was a preliminary study, no priori power analysis was performed using G*Power. Prior to the tests, participants were instructed to avoid intense physical activity for 72 hours and caffeine consumption for 2 hours. The study protocol was conducted in accordance with the latest version of the Declaration of Helsinki. Participants were informed about the potential risks and procedures of the study, and written informed consent was obtained.

Anthropometric Measurements

The height of the participants was measured without shoes, wearing shorts and a T-shirt. Height was measured with a manual stadiometer by determining the distance between the peak of the head and the sole of the foot. The data obtained were recorded in centimeters (cm). Body weight (kg), BMI (kg/m2), muscle mass (kg), and fat mass (kg) data were evaluated using bio-impedance Tanita (Tanita MC-980MA, Tokyo, Japan).

Eccentric Contraction via İsokinetic Dynamometer

Participants were tested in a seated position with their dominant leg on an isokinetic testing machine (Isoforce). The trunk, gluteal and hip regions were immobilized to prevent unwanted movements. During the measurements, the calibrated device was adjusted so that the range of motion was between 0° (full knee extension) and 90° (knee flexion). Eccentric contractions were performed in a single set of 5 repetitions at 60°/s and 150°/s, the common low and high angular velocities associated with torque production and neuromuscular activation, respectively (17). Participants were verbally motivated during the contractions. They were given all-out effort during to test.

Vertical Jump Test

Vertical Jump tests were performed with single leg (dominant leg) using My Jump Lab mobile application (18). All jumps were performed on a jump mat in order to correctly identify the moment of contact with the ground. The smartphone with the app was fixed on a tripod so that all images were recorded from a fixed angle, standardizing the measurement. Recordings were made using an iPhone 11 (Apple Inc., USA) at 1080p resolution and 60 frames per second (fps). The device was positioned approximately 3 meters away from the subjects at hip height to ensure consistency in angle and visibility. During the test, participants placed their hands at waist level and initiated a vertical jump with a single leg (dominant leg) from a squatting position corresponding to a knee flexion angle of approximately 120° (19). The dominant leg of the participants was determined by asking the question "Which leg would you use to kick the ball?" (20). In each condition, three repetitions were performed with a 1-minute rest interval and the best performance value was used for statistical analysis.

Statistical Analysis

All statistical analyses were performed using SPSS (IBM SPSS Statistics 25). The normality of the data distribution was assessed using the Shapiro–Wilk test. A one-way repeated measures ANOVA was conducted to examine the differences in jump performance across three conditions (control, 60°/s, and 150°/s) within the same group. Effect sizes were calculated using partial eta squared (η^2_p). Statistical significance was set at $p < 0.05$. Descriptive statistical data (mean ± standard deviation) for the control, 60°/s and 150°/s conditions are presented in a summary table. The performance values for the experimental conditions are compared with the control condition as a baseline. In addition, a paired sample t-test was performed to compare the torque values between 60°/s and 150°/s eccentric contraction conditions.

Ethical approval and institutional permission

The study was approved by Manisa Celal Bayar University Faculty of Medicine Health Sciences Ethics Committee (20.478.486/3122)

FINDINGS

As a result of the repeated measures ANOVA, there was no statistically significant difference in jump performance between interventions, $F(2, 14) = 1.66$, $p = .225$, $\eta^2_p = .192$. However, the partial eta squared value obtained indicates a high effect size. This suggests that even without statistical significance, the practical effects of the practices may be important (Figure 2). In addition to jump performance, peak eccentric torque values were compared between 60°/s and 150°/s conditions. The results showed that participants produced significantly higher torque at 60°/s (127.1 ± 10 Nm) compared to 150°/s (90.7 ± 28 Nm), (p = .003).

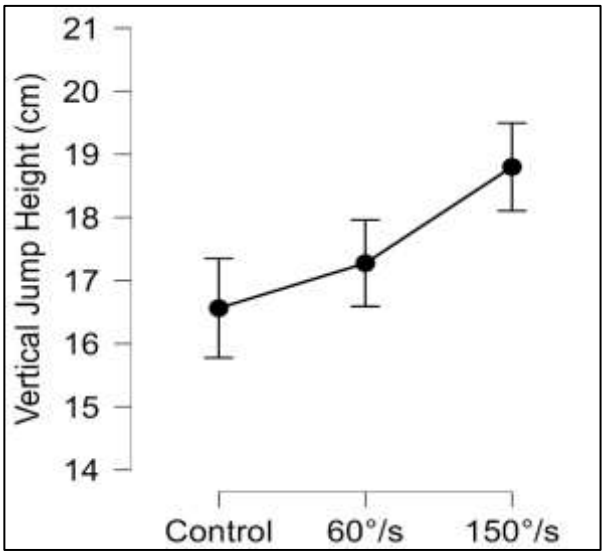


Figure 2. Mean vertical jump height under control, 60°/s, and 150°/s eccentric contraction conditions.

Table 1 presents descriptive statistics for vertical jump height according to the different intervention conditions (Control, 60°/s and 150°/s). The table includes effect sizes (Cohen's d) along with absolute (Δ cm) changes compared to the control condition. Although both eccentric protocols did not result in a statistically significant improvement, the 150°/s condition showed a significant increase in jump height and a moderate effect size compared to the control condition.

Table 1. Mean vertical jump height, absolute changes (Δ) and effect sizes (Cohen's *d*) compared to the control condition.

	Interventions	Mean ± SD	Δ (cm)	Cohen's *d*
Control	**60°/s**	17.27±3.87	+0.71	0.18
16.56±3.81	**150°/s**	18.80±4.16	+2.24	0.56

Note. Values represent group means (± SD) for vertical jump height of each condition. Δ (cm): Absolute change from control condition; Cohen's *d*: Effect size; 60°/s and 150°/s refer to the angular velocity of eccentric contractions.

DISCUSSION AND CONCLUSION

In this study, the effects of eccentric-based PAPE interventions performed in a single set of 5 repetitions at different angular velocities (60°/s and 150°/s) on jump performance were investigated. The findings showed that there was no statistically significant increase in jump height after both protocols (p>0.05). In addition, when the delta values were analyzed, jump height after 150°/s (+2.24 cm) was higher than 60°/s (+0.71 cm). This shows a tendency that an increase in angular velocity may contribute positively to performance by increasing the PAPE effect.

In the literature, it has been reported that torque production is either maintained or improved with increasing angular velocity in eccentric contractions, which may lead to more motor unit activation and increased muscle strength (21, 22). However, this development was not observed in the present study. The peak torque values produced by the participants in the 60°/s condition (127.1 Nm) were significantly higher than those in the 150°/s condition (90.7 Nm). This shows that lower angular velocities may also allow high force production in acute eccentric contractions. This difference may be due to factors such as decreased eccentric control at higher speeds, shorter time required for force production, or lack of technical proficiency. In chronic studies, it has been observed that eccentric loads at high speeds such as 180-210°/s cause more effective physiological adaptations (23, 24). These effects have been reported to be based on mechanisms such as increased motor unit recruitment during high-speed eccentric contractions and support of passive force production through Titin (25). Indeed, it has been reported that the type and intensity of contraction as well as the applied speed may play a determining role in the emergence of the PAPE effect (26). In this perspective, a higher angular velocity, such as 150°/s, increased jump performance more in the short term, supporting the idea that high-velocity eccentric contractions may enhance the PAPE effect. Similarly, in the literature has been reported that the relationship between muscle strength and jump performance may become better as angular velocity increases (27-30). Although these studies were mostly based on long-term training protocols, acute effects were evaluated in the present study. In the present study, the higher jump increase after eccentric loading at 150°/s compared to 60°/s (Δ +2.24 cm vs. +0.71 cm) may reflect the influence of the physiological processes described above on acute performance outcomes. The increase in the PAPE effect when angular velocity increases leads to the question "is there an optimal velocity range in angular velocity?". In this study, experiments at two different angular velocities showed a slight increase in potentiation with increasing velocity compared to the control. We would like to draw attention to the need for larger participant and detailed studies to optimize lower extremity angular velocity in future research.

In conclusion, this study examines the acute changes in jump performance of a single set of 5 repetitions of eccentric contractions performed at different angular velocities and showed that angular velocity may play a determining role in this change. In especially, eccentric contractions applied at higher angular velocity (150°/s) caused greater increases in jump performance, indicating that angular velocity may be an important factor in the emergence of the PAPE effect. The findings support that eccentric contractions can be used strategically not only for muscle strength development but also for the temporary enhancement of short-term explosive performance. In light of this, integrating eccentric contractions at high angular velocity (e.g., 150°/s) into pre-competition warm-up protocols may be considered as a potential method for short-term performance

enhancement. In branches where explosive force is critical, such practices may contribute to temporarily increasing performance outcomes such as jumping. However, such applications should be planned taking into account individual differences and should be previously evaluated whether the athlete has sufficient technical and physical capacity against eccentric load.

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REFERENCES

1. Perez-Gomez J, Calbet J. Training methods to improve vertical jump performance. J Sports Med Phys Fitness. 2013;53(4):339-57.
2. Scott SL, Docherty D. Acute effects of heavy preloading on vertical and horizontal jump performance. The Journal of Strength & Conditioning Research. 2004;18(2):201-5.
3. Tobin DP, Delahunt E. The acute effect of a plyometric stimulus on jump performance in professional rugby players. The Journal of Strength & Conditioning Research. 2014;28(2):367-72.
4. Genç S, Güdücü Ç, Çek ME, Mancı E, Günay E. The effect of resistance based post-activation performance enhancement interventions at different loads on maximal voluntary isometric contraction and muscle activation: Preliminary findings. Isokinetics and Exercise Science. 2025;33(2):161-70.
5. Dobbs WC, Tolusso DV, Fedewa MV, Esco MR. Effect of postactivation potentiation on explosive vertical jump: a systematic review and meta-analysis. The Journal of Strength & Conditioning Research. 2019;33(7):2009-18.
6. Smith IC, MacIntosh BR. A comment on "A new taxonomy for postactivation potentiation in sport". International Journal of Sports Physiology and Performance. 2021;16(2):163-.
7. Genç S, Mancı E, Güdücü Ç, Günay E. Post-Activation Performance Enhancement (PAPE) interventions at different loads may enhance sprint performance in well-trained athletes. Spor Hekimliği Dergisi. 2024;59(3):088-93.
8. Loturco I, Pereira LA, Zabaloy S, Mercer VP, Moura TB, Freitas TT, et al. No Post-Activation Performance Enhancement Following a Single Set of Plyometric or Flywheel Exercises in National Team Rugby Players. Applied Sciences. 2024;14(21).
9. Stastny P, Kolinger D, Pisz A, Wilk M, Petruzela J, Krzysztofik M. Effects of eccentric speed during front squat conditioning activity on post-activation performance enhancement of hip and thigh muscles. Journal of Human Kinetics. 2024;91(Spec Issue):5.
10. Lindstedt SL, LaStayo P, Reich T. When active muscles lengthen: properties and consequences of eccentric contractions. Physiology. 2001;16(6):256-61.
11. Douglas J, Pearson S, Ross A, McGuigan M. Eccentric exercise: physiological characteristics and acute responses. Sports Medicine. 2017;47:663-75.
12. Vogt M, Hoppeler HH. Eccentric exercise: mechanisms and effects when used as training regime or training adjunct. Journal of applied Physiology. 2014.
13. Bright TE, Handford MJ, Mundy P, Lake J, Theis N, Hughes JD. Building for the future: a systematic review of the effects of eccentric resistance training on measures of physical performance in youth athletes. Sports Medicine. 2023;53(6):1219-54.
14. Sarto F, Franchi M, Rigon P, Grigoletto D, Zoffoli L, Zanuso S, et al. Muscle activation during leg-press exercise with or without eccentric overload. European journal of applied physiology. 2020;120(7):1651-6.
15. Buker N, Savkin R, Suzer A, Akkaya N. Effect of eccentric and concentric squat exercise on quadriceps thickness and lower extremity performance in healthy young males. Acta Gymnica. 2021.
16. Akınoğlu B, Paköz B, Yilmaz AE, Shehu SU, Kocahan T. Effect of contraction type at varying angular velocities on isokinetic muscle strength training. Journal of exercise rehabilitation. 2023;19(4):228.
17. Michaut A, Pousson M, Babault N, Van Hoecke J. Is eccentric exercise-induced torque decrease contraction type dependent? Medicine & Science in Sports & Exercise. 2002;34(6):1003-8.
18. Bishop C, Jarvis P, Turner A, Balsalobre-Fernandez C. Validity and reliability of strategy metrics to assess countermovement jump performance using the newly developed my jump lab smartphone application. Journal of human kinetics. 2022;83:185.

19. Li M, Meng X, Guan L, Kim Y, Kim S. Comparing the effects of static stretching alone and in combination with post-activation performance enhancement on squat jump performance at different knee starting angles. Journal of Sports Science & Medicine. 2023;22(4):769.
20. Helbin J, Latocha A, Spieszny M, Ewertowska P, Wilk M, Krzysztofik M. Acute effects of unilateral conditioning activity on unilateral and bilateral jumping performance and bilateral strength asymmetry. Scientific Reports. 2025;15(1):10552.
21. Yamada Y, Ishii N. Differences in eccentric force-velocity characteristics between isotonic and isokinetic contractions. International Journal of Sport and Health Science. 2018;16:128-36.
22. Suchomel TJ, Wagle JP, Douglas J, Taber CB, Harden M, Haff GG, et al. Implementing eccentric resistance training—Part 1: A brief review of existing methods. Journal of Functional Morphology and Kinesiology. 2019;4(2):38.
23. Shepstone TN, Tang JE, Dallaire S, Schuenke MD, Staron RS, Phillips SM. Short-term high-vs. low-velocity isokinetic lengthening training results in greater hypertrophy of the elbow flexors in young men. Journal of applied physiology. 2005;98(5):1768-76.
24. Paddon-Jones D, Leveritt M, Lonergan A, Abernethy P. Adaptation to chronic eccentric exercise in humans: the influence of contraction velocity. European journal of applied physiology. 2001;85:466-71.
25. Douglas J, Pearson S, Ross A, McGuigan M. Chronic adaptations to eccentric training: a systematic review. Sports medicine. 2017;47(5):917-41.
26. Fan Z, Fan Z, Zhao Z, Zou Y, Zhang Q. The effect of velocity-based training on inducing post-activation performance enhancement. International Journal of Sports Medicine. 2025.
27. Yapici A, Findikoglu G, Dundar U. Do isokinetic angular velocity and contraction types affect the predictors of different anaerobic power tests? The Journal of sports medicine and physical fitness. 2014;56(4):383-91.
28. Rouis M, Coudrat L, Jaafar H, Filliard J, Vandewalle H, Barthelemy Y, et al. Assessment of isokinetic knee strength in elite young female basketball players: correlation with vertical jump. J Sports Med Phys Fitness. 2015;55(12):1502-8.
29. Chen C, Ali Z, Rashid MAR, Samethanovna MU, Wu G, Mukhametkali S, et al. Relationship between isokinetic strength of the knee joint and countermovement jump performance in elite boxers. PeerJ. 2023;11:e16521.
30. Cerrah AO, Bayram İ. Relatıonshıp Between Isokınetıc Strength, Vertıcal Jump, Sprınt Speed, Agılıty And Yo-Yo Intermıttent Recovery Test Performance In Soccer Players. European Journal of Physical Education and Sport Science. 2022;9(2).