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Jump squat as ergogenic aid through post-activation potentiation on horizontal and vertical jumping performance of untrained collegiate students

Salto con sentadilla como ayuda ergogénica a través de la potenciación post-activación en el rendimiento de saltos horizontales y verticales de estudiantes universitarios no entrenados

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Abstract

This study addresses research gaps by examining post-activation potentiation (PAP) effects on untrained collegiate students using diverse plyometric exercises. It evaluates the efficacy of jump squats as a physiological ergogenic aid, comparing bodyweight and externally loaded (10% body mass) jump squats on horizontal and vertical jumping performance in unilateral and bilateral variations. The study involved 76 untrained collegiate students (Female = 24, Male = 52) selected via purposive sampling, utilizing a quasi-experimental design. Vertical jump tests, single-leg vertical jump tests, standing broad jump tests, and single-leg broad jump tests measured performance pre- and post-intervention. Participants were divided into three groups: Group 1 (Female = 6, Male = 12) served as the control with no PAP protocol, Group 2 (Female = 10, Male = 15) performed 5x3 bodyweight jump squats, and Group 3 (Female = 8, Male = 18) performed 5x3 jump squats with 10% external load. Data analysis used paired t-tests and ANOVA. Results showed Group 1 improved only in bilateral vertical jump performance (pre-test: 50.48±11.57 cm, post-test: 53.84±11.52 cm, $t = 2.25$, $p < .05$). Group 2 exhibited no significant improvements in vertical or horizontal jumps. Group 3 improved bilateral vertical jump performance (pre-test: 53.81±15.41 cm, post-test: 59.12±15.03 cm, $t = 4.12$, $p = .00$). No significant horizontal jump improvements were observed across groups, and differences between groups were statistically insignificant. The findings suggest limited PAP effects on horizontal performance and emphasize the need for exercise patterns matching specific fitness or sports skills to enhance vertical performance. Recommendations include replicating the study for validation, refining data collection procedures, exploring other PAP protocols, and identifying optimal external loads for jump squats to maximize potentiation effects.

Keywords: squat, ergogenic aid, post-activation potentiation, jumping

Resumen

Este estudio aborda las brechas de investigación al examinar los efectos de la potenciación postactivación (PAP) en estudiantes universitarios no entrenados mediante diversos ejercicios pliométricos. Evalúa la eficacia de las sentadillas con salto como ayuda ergogénica fisiológica, comparando sentadillas con salto usando el peso corporal y con carga externa (10% de la masa corporal) en el rendimiento de saltos horizontales y verticales, en variaciones unilaterales y bilaterales. El estudio incluyó a 76 estudiantes universitarios no entrenados (24 mujeres, 52 hombres) seleccionados mediante muestreo intencional, utilizando un diseño cuasi-experimental. Se midió el rendimiento mediante pruebas de salto vertical, salto vertical con una pierna, salto de longitud y salto de longitud con una pierna, antes y después de las intervenciones. Los participantes se dividieron en tres grupos: el Grupo 1 (6 mujeres, 12 hombres) sirvió como control sin protocolo PAP; el Grupo 2 (10 mujeres, 15 hombres) realizó 5x3 sentadillas con salto usando el peso corporal, y el Grupo 3 (8 mujeres, 18 hombres) realizó 5x3 sentadillas con salto con una carga externa del 10%. Los datos se analizaron mediante pruebas t pareadas y ANOVA. Los resultados mostraron que el Grupo 1 mejoró únicamente en el salto vertical bilateral (pretest: 50.48±11.57 cm, postest: 53.84±11.52 cm, $t = 2.25$, $p < .05$). El Grupo 2 no mostró mejoras significativas en los saltos verticales ni horizontales. El Grupo 3 mejoró en el salto vertical bilateral (pretest: 53.81±15.41 cm,

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postest: 59.12±15.03 cm, t = 4.12, p = .00). No se observaron mejoras significativas en los saltos horizontales en ningún grupo, y las diferencias entre los grupos no fueron estadísticamente significativas. Los hallazgos sugieren efectos limitados de la PAP en el rendimiento horizontal y enfatizan la necesidad de patrones de ejercicio que coincidan con habilidades específicas de condición física o deportes para mejorar el rendimiento vertical. Se recomienda replicar el estudio para validación, refinar los procedimientos de recopilación de datos, explorar otros protocolos PAP e identificar cargas externas óptimas para maximizar los efectos de potenciación.

Palabras clave: sentadilla, ayuda ergogénica, potenciación post-activación, saltos.

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Introduction

Post Activation Potentiation (PAP)

Post Activation Potentiation (PAP) is a physiological phenomenon in which the muscle force output is temporarily boosted after a heavy resistance or high-intensity exercise (Brown & Loeb, 1998). It mostly affects fast-twitch muscle fibers. It was characterized by a temporary increase in muscular force at lower activation levels following a previous activation. It was suggested that a boost in athletic performance was seen in activities requiring power and strength (Brown & Loeb, 1998). The collegiate athletes' Vertical jump, shot put, and sprint performance was reported to improve due to PAP induced in the upper and lower body (Evetovich et al., 2015). For basketball players, sprint performance increased after inducing a training program combined with PAP (Tsimachidis et al., 2013). Swimmers' 100-m freestyle swim performance was also improved by PAP protocols (Hancock et al., 2015). The manipulation of the individual's muscular system through high-intensity or heavy resistance training to increase athletic parameters is classified as physiological ergogenic. Previous studies on different sports events suggest that PAP was effective as a physiological ergogenic aid.

Jumping

Jumping is defined as a basic human activity that refers to the propulsion of the body through forceful extension of the lower extremities (Yang, 2009). In the context of sports performance, this basic movement is very important for sports such as basketball and volleyball; where vertical jumping performance is high, jumping should be improved (Bobbert, 1990). Also, it was suggested that movement improvement can significantly increase overall athletic performance, not only in volleyball and baseball (Hrysomallis, 2012). This was true for track and field athletes as this movement is a key determinant of the sport's success, as athletes with better jumping performance also had superior skills in sprints, hurdles, and long jump events (Kobal et al., 2017). Lastly, jumping can lead to better aerobic and anaerobic capacity, which are essential to endurance and explosive movement sports (Hudgins et al., 2013). Jumping performance is also an essential indicator of maintaining a healthy lifestyle. As

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numerous studies suggested, a good horizontal jump performance correlated to a healthy life status among children and adolescents (Tomkinson et al., 2020). Specifically, it was also studied that its vertical variation is correlated with body composition, muscular fitness, and cardiorespiratory endurance (Hart, 2018). This was the same for the physical fitness component, muscular strength (Tounsi et al., 2015). The said correlation of jumping performance was also applicable to visually impaired youth (Pennell et al., 2021). Lastly, it was also associated with higher academic performance, linking physical fitness to cognition (Del Pozo et al., 2017). In a comparison between untrained males and trained athletes, it was found that untrained participants showed significantly lower performance in vertical jumping tasks. This suggests that explosive strength and neuromuscular coordination, honed through years of training, provide advanced athletes with better jump capabilities. The study concludes that years of training lead to neuromuscular adaptations that positively influence vertical jump performance (Zaggelidis et al., 2012). It was established that jumping performance was important not only for the improvement of athleticism but also for the maintenance of a healthy lifestyle. Its development should not only be aspired by athletes in sports which needs explosive lower extremities movement but also by all individuals as it is a predictor, and correlation of physical fitness parameters.

Heavy-loaded resistance exercises as PAP

Heavy-loaded resistance exercises involve lifting heavy weights, typically with high intensity, to enhance performance. For instance, studies show that using 80-130% of one-rep max (1RM) significantly improves explosive activities like jumping, throwing, and pushing in well-trained athletes (Gołaś et al., 2016). Specifically, lifting 85-90% 1RM with enough rest between sets benefits experienced athletes (Li et al., 2023). In another example, physically active women improved their 100-meter sprint times after performing a 4RM parallel back squat (Linder et al., 2010). Running speed also increased after doing 10 sets of half-back squats at 90% 1RM (Chatzopoulos et al., 2007).Significant improvements in jumping and sprinting performance were seen in athletes who performed back squats, such as NCAA Division II athletes who saw gains after a 3RM parallel back squat (Evetovich et al., 2015). Similarly, doing squats with

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different loads (30%, 50%, and 70% 1RM) increased force and power in athletes (Chiu et al., 2003). Higher jumps were achieved after doing 3RMs in squats (Esformes et al., 2010), and sprinting performance improved after performing back squats at 91% 1RM with customized recovery periods, showing the importance of individualized recovery (Bevan et al., 2010).

Plyometric exercises as PAP

Plyometric exercises, which involve explosive movements like jumping and sprinting, are also effective for PAP. These exercises help muscles reach maximum force quickly (Markovic & Mikulic, 2010). For example, plyometrics improved sprint performance in male track and field athletes (Creekmur et al., 2016). A combination of plyometrics and sled towing, along with caffeine ingestion, increased jump height in soccer players (Guerra Jr et al., 2018). In throwing events, hammer throwers achieved better distances after performing countermovement jumps and a 30-meter sprint (Karampatsos et al., 2013). Similarly, students achieved longer throw distances after five deep jumps (40 cm) (Terzis et al., 2009), and weight throwers improved their distance after performing countermovement jumps combined with a 20-meter sprint (Terzis et al., 2012).

Gaps, Aims, and Hypotheses of the Study

After reviewing the vast literature on post-activation potentiation used to increase athletic parameters, certain gaps were observed. First, the existing studies were only focused on physically active and trained individuals. This led to an incomplete investigation of post-activation potentiation among untrained individuals. The present study purposely investigates the effect of post-activation potentiation among untrained collegiate students. Secondly, previous studies focused only on one variation of plyometric exercise. With this, the extent to which a certain exercise can be used as post-activation potentiation cannot be fully investigated. The present study had two variations of jump squats: A jump squat and a variation with a load of 10 percent of the participant's body mass. Also, the two variations were compared with no post-activation protocol. Third, jumping performance as a variable was defined as having variations of horizontal and vertical. Furthermore, each direction of the jump was divided into the

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unilateral jumping performances of each lower extremity. In this inclusion, jump squats as post-activation potentiation can be investigated for their effect on jumping performance regarding direction and utilization of lower extremities. The study aimed to investigate the usage of two variations of jump squats as a physiological ergogenic aid by utilizing it as a post-activation potentiation protocol on jumping performance. Specifically, it investigated the effect of jump squats in two variations, using one's body weight and the other, with 10 percent external load on horizontal and vertical jumping performance on both unilateral and bilateral variations. Upon the review of the literature, hypotheses were drawn.

- H_1 No Post-activation Potentiation has an insignificant effect on Bilateral Vertical Jumping Performance;
- H_2 No Post-activation Potentiation has an insignificant effect on Unilateral Vertical Jumping Performance;
- H_3 No Post-activation Potentiation has an insignificant effect on Bilateral Horizontal Jumping Performance;
- H_4 No Post-activation Potentiation has an insignificant effect on Unilateral Horizontal Jumping Performance;
- H_5 Jump Squat has a significant effect on Bilateral Vertical Jumping Performance
- H_6 Jump Squat has a significant effect on Unilateral Vertical Jumping Performance;
- H_7 Jump Squat has a significant effect on Bilateral Horizontal Jumping Performance
- H_8 Jump Squat has a significant effect on Unilateral Horizontal Jumping Performance;
- H_9 Weighted Jump Squat has a significant effect on Bilateral Vertical Jumping Performance
- H_{10} Weighted Jump Squat has a significant effect on Unilateral Vertical Jumping Performance;
- H_{11} Weighted Jump Squat has a significant effect on Bilateral Horizontal Jumping Performance
- H_{12} Weighted Jump Squat has a significant effect on Unilateral Horizontal Jumping Performance;
- H_{13} There is a significant difference between the Bilateral Vertical Jumping Performance among the groups
- H_{14} There is a significant difference between the Unilateral Vertical Jumping Performance among the groups
- H_{15} There is a significant difference between the Bilateral Horizontal Jumping Performance among the groups

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H_{16} There is a significant difference between the Bilateral Horizontal Jumping Performance among the groups

Methodology

Sampling and Participants

The study consists of 76 untrained collegiate students who were selected through a purposive sampling method. The following qualifications were set as inclusion criteria of participant selection: (1) a bonafide student of the locale of the study, (2) does not have any formal athletic training, (3) without any medical problem that can be worsened or triggered by physical activity. Table 1 below shows the sex distribution of each group in the study. Group 1 consisted of 6 males (8.33%) and 19 females (25.00%), which completed 33.33% of the 76 participants. As for Group 2, there were ten males (13.16%) and 15 females (19.74%), which included 33.33% of the total participants. Lastly, Group 3 has 26 (33.34%) participants, which consist of 8 males (10.53%) and 18 females (22.81%). In totality, the 76 participants of the study were grouped into three groups that represent the different implementations.

Table 1. Sex distribution of the participants per group

Sex	Group 1	Group 2	Group 3	Total
Female	6 (8.33%)	10 (13.16%)	8 (10.53%)	24 (31.58%)
Male	19(25.00%)	15 (19.74%)	18 (22.81%)	52 (68.42%)
Total	25(33.33%)	25(33.33%)	26(33.34%)	76 (100%)

Table 2 represents the participants' demographic profiles in terms of height, weight, and body mass index per group. Group 1 had a mean age of 21.02+2.35, a mean height of 167.84±10.33, and a mean weight of 66.05±10.81. With this, the Body mass index of the group was 23.44±3.36. As for group 2, the mean age of 20.56+2.11, the mean height was 166.24±8.10, and the mean weight was 58.56±11.52. The body mass index of the group was 21.04±2.87. Group 3 had a mean age of 20.80+1.98, a body mass index of 2220±3.44, a mean weight of 167.58±9.26, and a mean weight of 62.66±12.67. In totality, the participants had a mean age of 20.79+2.17, a mean height

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of 167.58±9.26, and a mean weight of 62.66±12.67. The body mass index of the participants was reported to be 22.20±3.44.

Table 2. Demographic profile of the participants per group

Sex	Group 1	Group 2	Group 3	Total
Age	21.02+2.35	20.56+2.11	20.80+1.98	20.79+2.17
Height	167.84±10.33	166.24±8.10	168.62±9.05	167.58±9.26
Weight	66.04±10.81	58.56±11.52	63.35±14.27	62.66±12.67
Body Mass Index	23.44±3.36	21.04±2.87	22.12±3.62	22.20±3.44

Instruments

To investigate the effect of jump squats as an ergogenic aid through post-activation potentiation on jumping performance, several field tests designed to measure jumping capability were used.

Vertical jump test

As for the bilateral vertical jumping performance, the vertical jump test (Klavora, 2000) was utilized. Mainly, it assesses the lower extremities' power in delivering simultaneous extension of the hip, knee, and ankle joints (Vanezis & Lees, 2005). A vertical jump test was performed using the jump and reach method. To perform the method, the participant marks the highest standing reach on a wall, then jumps as high as possible to make a second mark. The vertical jump height is determined by measuring the distance between these two marks, with the test repeated three times for accuracy. The method was used because of its practicality. However, the validity of the testing was not compromised as the method was found to be highly correlated to the motion analysis system (r=.906) (Menzel et al., 2010).

Single-leg vertical jump test

As for the unilateral vertical jumping performance, a single-leg vertical jump was utilized. The test was designed to assess the functional performance of the unilateral lower extremity, focusing on strength, power, and balance (Lee et al., 2018). It was also used as a test for the functionality of athletes post-ACL reconstruction and to determine readiness to return to sport (Kim et al., 2016). The same as the vertical jump

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test, the test was done using the jump and reach method. It had the same protocol as the vertical jump test. However, the jump was done using one leg for three trials. After this, the other leg was also tested. The reliability of the test was established by having high reliability with intraclass correlation coefficients (ICC) greater than 0.85, indicating consistency in trials and sessions (McElveen et al., 2010). Also, it has a low coefficient of variation (Stålbom et al., 2007) and moderate-to-excellent Test-retest reliability (Vieira et al., 2021).

Standing broad jump test

The bilateral horizontal jumping performance was quantified using the standing broad jump test. It was a widely used valid instrument to assess leg power, involving jumping forward as far as possible from standing (Thomas et al., 2020). The participant stands behind a starting line with feet shoulder-width apart, swings their arms back and forward while bending their knees, and jumps forward as far as possible, landing on both feet. The distance from the starting line to the back of the closest heel is measured, with typically three trials conducted and the best jump recorded (Caskey, 1968). The instrument's reliability was established as it had an intraclass correlation coefficient of .96 for male raters and .99 for female raters (Rahman, 2021). Also, the test-retest reliability of the instrument was established by having r=96 among males and r=.90 for females (Rahman, 2021). Lastly, it can discriminate elite from non-elite athlete’s horizontal jumping performance (Rahman, 2021).

Single-leg standing broad jump test

A single-leg standing broad jump test was utilized for the unilateral variation of horizontal jumping. It was a variation of the traditional standing broad jump test (Pérez-Castilla et al., 2021). However, the test was performed using one lower extremity at a time. With the non-jumping leg bent, the participant stands on one leg behind a starting line, then swings their arms and performs a countermovement jump, landing on the same leg while maintaining balance. The distance from the starting line to the heel of the landing leg is measured, with typically three trials conducted for each leg to ensure accuracy and the best jump recorded (Rahman, 2021). The instrument was established to have an acceptable absolute reliability with bilateral standing broad jump test on

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mean velocity, peak force, peak velocity, and impulse (CV range = 3.65-9.81%) (Pérez-Castilla et al., 2021).

Data gathering procedure

Standardization of muscular system and diet

Before the administration of the jumping tests, the muscular system and diet of the participants were ensure to not be affected by various circumstances such as existing training program and diet. The participants were asked to refrain from any moderate to vigorous physical activity for 48 to 72 hours. This was to ensure recovery of muscular system from probable existing physical activities and prevention of impaired jumping performance (Carroll et al., 20217). Also, on this period, consumption of beverages that can influence performance such as stimulants, in form of coffee, energy drink (Blanchard & Sawers, 2004; Magkos and Kavouras, 2005) and the likes, and alcohol (Jones, 2010) were advised to be stopped. With this protocols, the threat of external validity was minimized.

Jumping tests protocols

The jump squat was defined as performing a countermovement jump starting with a standing position followed by an immediate eccentric squat phase and concluded by a sudden extension of the lower extremities joint. The mechanics of the jump squat was thoroughly practiced by the participants before the start of the data gathering. There were four jumping performance tests administered to each participant. In order to prevent compounding effects such as fatigue, and post-activation potentiation, strict test protocol was observed. Here is the order of the jumping test administration: (1) Vertical jump test. (2) Single-leg vertical jump tests, (3) Standing broad jump test, (4) Single-leg standing broad jump test. The trials per test were done 15-30 seconds after the previous jump. This was done for the participants to recover and have the optimal performance for the next jump (Nelson et al., 2018; Padulo et al., 2015; Read and Cisar, 2001). On the recovery time between jump tests, 12-15 minutes were used to ensure muscle recovery and prevent between-test compounding effect due to post-activation potentiation (Sue et al., 2016). However, the participants who did not feel recovered from the jump test trials or jump test despite of following the set recovery time were

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permitted to rest and recover longer than the suggested recovery time. It was suggested that individualized recovery from exercises should also be implemented (Cortis et al., 2010).

Pretesting

The participants were administered the selected jumping performance test. The procedure and protocols for the aforementioned tests were followed strictly to ensure a quality test administration.

Administration of jump squat as post-activation potentiation and post-testing

After the pretesting, three groups were randomly formed—different pre-jumping test routines were administered to each group. Group 1 did the same testing protocol as the pretesting. Group 2 did 5 x 3 jump squats 5 minutes before the first two vertical jumping tests. After the aforementioned time, the participants were administered the vertical jump and single-leg vertical jump tests. After this, the participant recovers for 12-15 minutes to prevent the compounding effect of post-activation potentiation (Sue et al., 2019). Another administration of 5 x 3 jump squats was done 5 minutes prior to the horizontal jumping tests. The participants were administered the standing broad jump test followed by a single-leg standing broad jump. For Group 3, the same as Group 2, but the jump squat was done with a dumbbell, which weighs 10 percent of the participant's body weight. The post-test commenced three days after the pretesting.

Data analysis

The study utilized a paired t-test for within-group comparison of the three groups implemented by different jump squat variations as ergogenic aid. The post-test data of each group was also compared with that of the other. With this, an analysis of variance was used. Parametric tests were employed in this study based on the assumption that the data follows a normal distribution. While this assumption can be difficult to verify in smaller samples, the central limit theorem suggests that, for sample sizes of 30 or more, the distribution of the sample mean approximates normality, even when the underlying population distribution is not perfectly normal. Therefore, with a sample size of 76, parametric tests were deemed appropriate for this analysis Lastly, the

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significance level of .05 was selected. P-values equal to or less than the set significance level was interpreted as significant.

Potential Ethical Issue

The study underwent and passed the Local Ethics Committee of the College of Sports, Exercise, and Recreation, Bulacan State University, with control number CSER-CRDU-2024-030. Also, this study adheres to the ethical principles of the Declaration of Helsinki, ensuring respect for the dignity, rights, and welfare of all participants. They were given a comprehensive briefing on the study, which included a discussion about their rights within the study context. Afterward, individuals were asked to provide informed consent by completing a consent letter. Subsequently, a Physical Readiness Questionnaire was administered to ascertain the presence of any concealed medical conditions among the subjects. To conclude, it is essential to emphasize that the acquired data was handled with utmost confidentiality and disclosed to the owner upon request.

Results

Table 3 shows the pretest and post-test results of vertical jumping performance without any post-activation potentiation protocols. Surprisingly, there was an improvement (t =2.25, p<.05) in the bilateral vertical jumping performance (VJT ^{pretest}=50.48±11.57 cm, VJT $^{post\text{-}test}$=53.84±11.52 cm) of the participants even in the absence of jump squats as a post-activation potentiation protocol. However, improvement was not observed for unilateral vertical jumping for both right (SLVJT (R) ^{pretest}=42.76±27.89 cm, SLVJT (R) $^{post\text{-}test}$=37.32±8.74 cm, t=.99, p=.33) and left lower extremities (SLVJT (L) ^{pretest}=41.56±28.81 cm, SLVJT (L) ^{pretest}=36.56±9.94 cm, t=.94, p=.36) without the implemented Post-activation potentiation protocol. With this, H_1 was rejected, but H_2 was accepted.

Meanwhile**,** It also shows the pretest and post-test results of horizontal jumping performance. Surprisingly, there was no significant improvement in the standing broad jump performance (SBJT ^{pretest} = 198.72 ± 41.25 cm, SBJT $^{post\text{-}test}$ = 208.36 ± 38.88 cm, t = 1.13, p = .27) of the participants. Similarly, no significant improvement was observed for unilateral horizontal jumping for both right (SLSBJT (R) ^{pretest} = 171.60 ± 31.29 cm,

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SLSBJT (R) $^{post\text{-}test}$ = 168.28 ± 31.41 cm, t = 0.88, p = .39) and left lower extremities (SLSBJT (L) ^{pretest} = 167.84 ± 35.83 cm, SLSBJT (L) $^{post\text{-}test}$ = 166.36 ± 35.40 cm, t = 0.39, p = .70) without the implemented post-activation potentiation protocol. With this, H_3 and H_4 were accepted.

Table 3. No post-activation potentiation protocol jumping

Jumping Test	Pretest	Post-test	t-value	p-value
		Vertical Jumping		
VJT	50.48±11.57 cm	53.84±11.52 cm	2.25	*p*<.05
SLVJT (R)	42.76±27.89 cm	37.32±8.74 cm	.99	.33
SLVJT (L)	41.56±28.81 cm	36.56±9.94 cm	.94	.36
		Horizontal Jumping		
SBJT	198.72±41.25 cm	208.36±38.88 cm	1.13	.27
SLSBJT (R)	171.60±31.29 cm	168.28±31.41 cm	.88	.39
SLSBJT (L)	167.84±35.83 cm	166.36±35.40 cm	.39	.70

Note: Significance *p*<.05, VJT-Vertical Jump Test, SLVJT (R) – Single-leg Vertical Jump Test (Right), SLVJT (L) – Single-leg Vertical Jump Test (Left), SBJT-Standing Broad Jump Test, SLSBJT (R)-Single-Leg Standing Broad Jump Test (Right), SLSBJT (L)- Single-Leg Standing Broad Jump Test (Left)

Table 4 shows the pretest and post-test results of vertical jumping performance with 5x3 jump squats as a post-activation potentiation protocol. Surprisingly, there was no significant improvement in the bilateral vertical jumping performance (VJT ^{pretest} = 51.16 ± 12.47 cm, VJT $^{post\text{-}test}$ = 52.64 ± 12.03 cm, t = 1.21, p = .24) of the participants. However, significant improvement was observed for unilateral vertical jumping for both right (SLVJT (R) ^{pretest} = 32.28 ± 8.14 cm, SLVJT (R) $^{post\text{-}test}$ = 36.72 ± 7.13 cm, t = 3.09, p>.05) and left lower extremities (SLVJT (L) ^{pretest} = 30.36 ± 9.75 cm, SLVJT (L) $^{post\text{-}test}$ = 36.60 ± 8.14 cm, t = 3.70, p>.05) with the implemented Post-activation potentiation protocol. With this, H_5 was rejected, but H_6 was accepted.

Meanwhile. It also shows the pretest and post-test results of horizontal jumping performance. Surprisingly, there was no significant improvement in the standing broad jump performance (SBJT ^{pretest} = 203.52 ± 35.93 cm, SBJT $^{post\text{-}test}$ = 207.12 ± 40.14 cm, t = 1.07, p = .29) of the participants. Similarly, no significant improvement was observed

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for unilateral horizontal jumping for both right (SLSBJT (R) ^{pretest} = 168.88 ± 29.68 cm, SLSBJT (R) $^{post\text{-}test}$ = 167.96 ± 26.22 cm, t = 0.26, p = .79) and left lower extremities (SLSBJT (L) ^{pretest} = 168.40 ± 28.04 cm, SLSBJT (L) $^{post\text{-}test}$ = 164.20 ± 23.70 cm, t = 1.35, p = .19) with the implemented post-activation potentiation protocol. With this, H_7 and H_8 were rejected.

Table 4. Jumping with 5x3 jump squat as a post-activation potentiation protocol

Jumping Test	Pretest	Post-test	t-value	p-value
		Vertical Jumping		
VJT	51.16±12.47 cm	**52.64±12.03** cm	1.21	.24
SLVJT (R)	32.28±8.14 cm	36.72±7.13 cm	3.09	*p*<.05
SLVJT (L)	30.36±9.75 cm	36.60±8.14 cm	3.70	*p*<.05
		Horizontal Jumping		
SBJT	203.52±35.93 cm	207.12±40.14 cm	1.07	.29
SLSBJT (R)	168.88±29.68 cm	167.96±26.22 cm	.26	.79
SLSBJT (L)	168.40±28.04 cm	164.20±23.70 cm	1.35	.19

Note: Significance *p*<.05, VJT-Vertical Jump Test, SLVJT (R) – Single-leg Vertical Jump Test (Right), SLVJT (L) – Single-leg Vertical Jump Test (Left), SBJT-Standing Broad Jump Test, SLSBJT (R)- Single-Leg Standing Broad Jump Test (Right), SLSBJT (L)- Single-Leg Standing Broad Jump Test (Left)

Table 5 shows the pretest and post-test results of vertical jumping performance with 5x3 weighted jump squats as an Post-activation potentiation protocol. There was a significant improvement in the bilateral vertical jumping performance (VJT ^{pretest} = 53.81 ± 15.41 cm, VJT $^{post\text{-}test}$ = 59.12 ± 15.03, t = 4.12, p = .00) of the participants. However, no significant improvement was observed for unilateral vertical jumping for both right (SLVJT (R) ^{pretest} = 36.08 ± 11.26 cm, SLVJT (R) $^{post\text{-}test}$ = 39.08 ± 10.48 cm, t = 1.82, p = .08) and left lower extremities (SLVJT (L) ^{pretest} = 36.23 ± 11.57 cm, SLVJT (L) $^{post\text{-}test}$ = 38.46 ± 11.78 cm, t = 1.44, p = .16) with the implemented Post-activation potentiation protocol. With this, H_9 was accepted but H_{10} was rejected.

Meanwhile, it shows the pretest and post-test results of horizontal jumping performance. Surprisingly, there was no significant improvement in the standing broad jump performance (SBJT ^{pretest} = 203.65 ± 35.52 cm, SBJT $^{post\text{-}test}$ = 206.00 ± 34.00 cm, t

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= 0.84, p = .41) of the participants. Similarly, no significant improvement was observed for unilateral horizontal jumping for both right (SLSBJT (R) ^{pretest} = 172.73 ± 33.31 cm, SLSBJT (R) $^{post\text{-}test}$ = 171.85 ± 26.98 cm, t = 0.37, p = .72) and left lower extremities (SLSBJT (L) ^{pretest} = 172.00 ± 31.43 cm, SLSBJT (L) $^{post\text{-}test}$ = 170.50 ± 25.79 cm, t = 0.62, p = .54) with the implemented post-activation potentiation protocol. H_{11} and H_{12} were rejected.

Table 5. Jumping with a 5x3 weighted jump squat as a post-activation potentiation protocol

Jumping Test	Pretest	Post-test	t-value	p-value
		Vertical Jumping		
VJT	53.81±15.41 cm	59.12±15.03 cm	4.12	*p*<.05
SLVJT (R)	36.08±11.26 cm	39.08±10.48 cm	1.82	.08
SLVJT (L)	36.23±11.57 cm	38.46±11.78 cm	1.44	.16
		Horizontal Jumping		
SBJT	203.65±35.52 cm	206.00±34.00 cm	.84	.41
SLSBJT (R)	172.73±33.31 cm	171.85±26.98 cm	.37	.72
SLSBJT (L)	172.00±31.43 cm	170.50±25.79 cm	.62	.54

Note: Significance *p*<.05, VJT-Vertical Jump Test, SLVJT (R) – Single-leg Vertical Jump Test (Right), SLVJT (L) – Single-leg Vertical Jump Test (Left), SBJT-Standing Broad Jump Test, SLSBJT (R)- Single-Leg Standing Broad Jump Test (Right), SLSBJT (L)- Single-Leg Standing Broad Jump Test (Left)

Table 6 shows the comparison between different post-activation potentiation protocols implemented before VJTs. For bilateral vertical jumping performance, the post-test data (VJT ^{NPAP}=53.84±11.52 cm, VJT ^{JS}=52.64±12.03 cm, VJT ^{WJPS}=59.12±15.03 cm) among the three groups were found to be insignificantly different (f=.52, p =.60). For unilateral vertical jump, the right (SLVJT (R) ^{NPAP}=37.32±8.74 cm, SLVJT (R) ^{JS}=36.72±7.13 cm, SLVJT (R) ^{WJPS}=39.08±10.48 cm) and left (SLVJT (L) ^{NPAP}=36.56±9.94 cm, SLVJT (L) ^{JS}=36.60±8.14 cm, SLVJT (L) ^{WJPS}=38.46±11.78 cm) extremities were found to have insignificant difference (*right*: f=.45, p=.64) (*left*: f=1.51,p=.24) among the three groups.

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Meanwhile, it also shows the comparison between different post-activation potentiation protocols implemented before horizontal jump tests. For bilateral horizontal jumping performance, the post-test data (SBJT ^{NPAP} = 208.36 ± 38.88, SBJT ^{JS} = 207.12 ± 40.14, SBJT ^{WJPS} = 206.00 ± 34.00) among the three groups were found to be insignificantly different (f = 0.08, p = 0.92). For unilateral horizontal jump, the right (SLSBJT (R) ^{NPAP} = 168.28 ± 31.41 cm, SLSBJT (R) JS = 167.96 ± 26.22 cm, SLSBJT (R) ^{WJPS} = 171.85 ± 26.98) and left (SLSBJT (L) ^{NPAP} = 166.36 ± 35.40 cm, SLSBJT (L) ^{JS} = 164.20 ± 23.70, SLSBJT (L) ^{WJPS} = 170.50 ± 25.79 cm) extremities were found to have insignificant differences (*right*: f = 0.12, p = 0.89; *left*: f = 0.19, p = 0.83) among the three groups. H13, H14, H15 and H16 were rejected

Table 6. Comparison of Jumping Performance among Groups

Jumping Test	NPAP	JS	WJS	f-value	p-value
		Vertical Jumping			
VJT	53.84±11.52 cm	52.64±12.03 cm	59.12±15.03 cm	.52	.60
SLVJT (R)	37.32±8.74 cm	36.72±7.13 cm	39.08±10.48 cm	.45	.64
SLVJT (L)	36.56±9.94 cm	36.60±8.14 cm	38.46±11.78 cm	1.51	.24
		Horizontal Jumping			
SBJT	208.36±38.88 cm	207.12±40.14 cm	206.00±34.00 cm	.08	.92
SLSBJT (R)	168.28±31.41 cm	167.96±26.22 cm	171.85±26.98 cm	.12	.89
SLSBJT (L)	166.36±35.40 cm	164.20±23.70 cm	170.50±25.79 cm	.19	.83

Note: Significance p<.05, VJT-Vertical Jump Test, SLVJT (R) – Single-leg Vertical Jump Test (Right), SLVJT (L) – Single-leg Vertical Jump Test (Left), SBJT-Standing Broad Jump Test, SLSBJT (R)-Single-Leg Standing Broad Jump Test (Right), SLSBJT (L)- Single-Leg Standing Broad Jump Test (Left), NPAP- No Post-activation Potentiation, JS-Jump Squat, WJS- Weighted Jump Squat

Discussion

Jump squat

The study had limitations that can be recommended for further investigation within the research topic. The post-activation protocol used in the study includes two variations of jump squats. One whose load is purely body weight and the other, with an external weight of 10 percent of the participant's body mass, was supplied by dumbells.

The jump was directed vertically. The other direction of jumping, such as horizontal and lateral, was not used for post-activation potentiation. As for the jumping performance, it was divided based on direction, vertically and horizontally. These categories were further divided into unilateral and bilateral. The result of the study only limits this type of jumping. Other directions of the jump, such as lateral and backward, were not investigated. Lastly, the field tests used in the study were validated and reliable. However, it may limit the data it can produce to vertical and horizontal distances of jumps.

The study conducted a within-group comparison among the three groups. A paired t-test was used to analyze whether the changes recorded in jumping performance were significant were significant. For Group 1, which did not receive any post-activation potentiation protocol, H_1 was rejected, but H_2 was accepted. The improvement was seen in vertical jumping performance. However, an insignificant drop in performance was observed for the unilateral vertical jumping of both lower extremities. In the absence of a jump squat as an ergogenic aid, the bilateral vertical jump performance was seen to have improved. This can be explained by short-term recovery. Even a short period of recovery, such as three days after the pretesting, slight improvements in performance can be attributed to muscle recovery and reduced fatigue (Santos et al., 2016). Also, neuromuscular adaptations within a short timeframe are assumed to contribute to this improvement (Šarabon et al., 2020). Not only the physiological aspect should be scrutinized, but also the psychological aspect. The learning effect can contribute to the performance increase as the participants tend to be more familiar with the field tests administered to them (Massuca & Branco, 2016). As familiarity with the test sets in, reduced anxiety is likely as the participants were already experienced with administering the field test (Van Raalte et al., 2015). With this, increased motivation can also be a reason, as the pretest scores were shared with the participants, which might have enhanced their motivation to aim for a higher score (McEwan et al., 2019). As for the horizontal jumping performance, H_3 and H_4 were accepted. There was an insignificant change in both the bilateral and unilateral horizontal jumping performance. Previous studies can confirm the result of the study on

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horizontal jumping performance. Implementing paused box squats as a post-activation potentiation protocol before the standing broad jump did not significantly improve bilateral jumping (Seitz et al., 2016). Regarding unilateral jumping performance, Horizontal drop jumps, and other dynamic resistance and weighted plyometric exercises before an activity improves sprinting performance compared to control counterparts (Kitani et al., 2020; Piper et al., 2020). The result suggests that without post-activation potentiation protocol, such as jump and squat, can hinder the execution of maximum horizontal performance among the participants. The results further discuss post-activation potentiation, particularly in setting a baseline group. When creating the data-gathering procedure, physiological and psychological changes from the pretest to the post-test should be considered. Further studies are suggested to create a more robust and rigorous data-gathering procedure concerning baseline groups.

As for Group 2, who did 5 x 3 jump squats prior to the jumping performance testing, With this, H_5 was rejected, but H_6 was accepted. The improvement was not seen in the bilateral vertical jumping performance. However, the unilateral jumping performance of both lower extremities was found to be improved by the 5 x 3 jump squat. No previous studies can directly support the improvement of unilateral vertical jumping performance due to jumping squats, a plyometric exercise used as a post-activation potentiation protocol. Some studies used unilateral exercises such as PAP to increase bilateral, counter-movement jump performance (Iacono et al., 2016). However, the causal relationship was different from what the present study portrayed. Certain principles and studies can indirectly explain the result. Neuromuscular adaptations and transfer can explain that bilateral exercises such as jump squats can enhance neuromuscular efficiency and can be transferred to unilateral tasks such as single-leg vertical jump tests (Liao et al., 2021). Bilateral deficit refers to the higher total force produced by unilateral movements than bilateral counterparts (Botton et al., 2016). However, bilateral exercise training can improve unilateral movements due to increased neural drive and intermuscular coordination (Liao et al., 2021). Although there was a lack of specificity in terms of the movement of the jump squat, bilateral plyometric training can still improve both bilateral and unilateral jumping performance (Makaruk et

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al., 2011). As for the horizontal jumping performance, H_7 and H_8 were rejected. There was an insignificant change in both the bilateral and unilateral horizontal jumping performance. Likewise, no studies can directly support the present study's result. However, principles and several studies can indirectly explain it. Training specificity is essential in training to promote desired adaptations (Coffey & Hawley, 2017; Stankovic et al., 2019). The jump squat as a post-activation potentiation protocol was not specific for horizontal jumping in terms of movement. Moreover, a jump squat is a vertical jumping movement that demands the body to be propelled upward through the explosive extension of the lower extremities' joint. With this, insignificant improvement can be linked to the principle of specificity. The results of the study in terms of using jump squats as post-activation potentiation to improve horizontal and vertical jumping performance opens a discussion on the potential subject of research, such as bilateral vertical jumping exercises as jump squats are used as a post-activation potentiation protocol on unilateral vertical jumping performance, and movement specificity consideration in implementing the post-activation potentiation protocol. Future studies were suggested to replicate the study to validate the result and implement other PAP protocols to enhance jumping performance.

Lastly, Group 3 performed weighted jump squats as post-activation potentiation. H_9 was accepted but H_{10} was rejected. Bilateral vertical jumping performance was found to be enhanced by the weighted 5x3 jump squat. However, an insignificant increase in performance was observed for the unilateral vertical jumping of both lower extremities. There was a scarcity of studies that could support the results directly. An 8-week Weighted jump-squat training program increased soccer players' agility and sprint performance (Coratella et al., 2018). However, the study focused on the long-term effect of weighted jump squats on certain fitness parameters. With this, the result of the present study opens a discussion on the acute effect of weighted jump squats on parameters such as bilateral vertical jumping performance. The principles such as specificity (Coffey & Hawley, 2017; Stankovic et al., 2019) may explain the result. The movement in the said post-activation potentiation was similar to the bilateral vertical jump test. This similarity is a contributing factor to the improvement in the jumping

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performance. This also explained the insignificant improvement in the unilateral vertical jumping performance. Since the jumping mechanics of the said jumping performance are far in terms of the movement pattern, potentiation was not transferred. Moreover, in bilateral and unilateral horizontal jumping, H_{11} and H_{12} were rejected. The performance improvement was also not seen because of the different movement patterns of the post-activation potentiation protocol to the jumping mechanics. This implies that post-activation potentiation activity with the same movement pattern as the actual fitness or sports skill significantly improves the fitness or sports skill. Future studies were suggested to administer a post-activation potentiation protocol specific to the fitness parameters or sports skills that need improvement.

After implementing respective post-activation potentiation, the study also compared the three groups' jumping performance. It was revealed that H_{13}, H_{14}, H_{15} and H_{16} were rejected. The differences in the post-test data of the three groups was analyzed using analysis of variance. Vertical and horizontal jumping performance for both bilateral and unilateral lower extremities among the groups was found to be insignificantly different from each other. With this, there was no superior post-activation potentiation in improving jumping performance among the participants. With the scarcity of studies that compare body weight versus weighted plyometric exercise as a post-activation potentiation protocol, there needs to be a study that can directly support the study. However, several studies may indirectly explain the result of the study. Post-activation potentiation relies on a high-intensity stimulus, such as plyometric or heavy resistance exercises, to enhance subsequent performance (Brown & Loeb, 1998). With this, both body weight and weighted plyometric exercises might provide similar potentiation to jumping performance. It can be assumed that 10 percent of the participant’s mass as an external load to jump squat is inadequate to trigger potentiation. In a study about boxers, plyometric training with external weights improves power endurance but not punching power (Bružas et al., 2018). Although the study investigated the effect of plyometric exercises induced as a training program, it explained plyometric exercises performed with external loads. Also, plyometric exercise used as a training program and post-activation potentiation were correlated as the level

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of potentiation depends on the individual's strength and resistance training experience (Seitz & Haff, 2016). On the other hand, adding external weight in jump squats as post-activation potentiation can increase the likelihood of fatigue, jeopardizing the potentiation effect. If the weighted plyometric exercise, jump squat, induces more fatigue than bodyweight exercises, the potentiation effect might not be triggered, resulting in no significant difference in performance outcomes. A study suggested that using additional weight in plyometric exercises such as sprint as post-activation potentiation should be further studied by implementing varying external weights (Turner et al., 2015). The result of the present study opens a discussion on external load on plyometric exercise as a post-activation potentiation protocol—specifically, the weight of the external load where it will induce potentiation or fatigue. Future studies were suggested to investigate jump squats' optimal external load weight to induce superior potentiation on fitness parameters.

Conclusion

The three groups were tested for vertical and horizontal jumping performance under different post-activation potentiation protocols. Group 1, which received no post-activation potentiation protocol, showed an improvement in bilateral vertical jump performance, while the unilateral vertical jump and both horizontal jumps exhibited insignificant changes. Group 2, who performed 5x3 jump squats prior to the testing, exhibited an improvement in unilateral vertical jump performance. However, improvements in bilateral vertical or horizontal jumps were not observed. Lastly, Group 3, who performed weighted jump squats, exhibited enhanced bilateral vertical jump performance with no significant enhancement on unilateral vertical and horizontal jumps. In totality, the differences in jumping performance between the groups were statistically insignificant. The study suggests that the absence of post-activation potentiation protocols, like jump squats, may limit maximum horizontal performance and highlights the need to account for physiological and psychological changes when setting baseline groups. The findings on using jump squats as post-activation potentiation to enhance horizontal and vertical jumping performance suggest further research on the effectiveness of bilateral vertical jumping exercises for improving

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unilateral performance, with an emphasis on movement specificity in PAP protocols. It also implies that post-activation potentiation activity with the same movement pattern as the actual fitness or sports skill significantly improves the fitness or sports skill. Lastly, it also prompts a discussion on the use of external load in plyometric exercises as a post-activation potentiation protocol, specifically focusing on the optimal weight that induces potentiation without causing fatigue. Further studies are recommended to develop more robust and rigorous data-gathering procedures, particularly concerning baseline groups. Replicating the study is also suggested to validate the results, and the implementation of alternative PAP protocols to enhance jumping performance should be explored. Additionally, it is recommended that Post-Activation Potentiation (PAP) protocols be tailored specifically to the fitness parameters or sports skills requiring improvement. Future research should also investigate the optimal external load for jump squats to maximize potentiation effects on fitness outcomes

References

Aguiar, A., Speck, A. E., Canas, P., & Cunha, R. (2020). Neuronal adenosine A2A receptors signal ergogenic effects of caffeine. *Scientific Reports, 10.* https://doi.org/10.1038/s41598-020-69660-1

Ahrendt, D. (2001). Ergogenic aids: Counseling the athlete. *American Family Physician, 63*(5), 913-922.

Andersen, A. B., Nordsborg, N., Bonne, T., & Bejder, J. (2022). Contemporary blood doping - performance, mechanism, and detection. *Scandinavian Journal of Medicine & Science in Sports.* https://doi.org/10.1111/sms.14243

Applegate, E., & Grivetti, L. (1997). Search for the competitive edge: A history of dietary fads and supplements. *The Journal of Nutrition, 127*(5 Suppl), 869S-873S. https://doi.org/10.1093/jn/127.5.869S

Revista Técnico-Científica del Deporte Escolar, Educación Física y Psicomotricidad
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Editor: University of A Coruña. A Coruña. Spain
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Bevan, H. R., Cunningham, D. J., Tooley, E. P., Owen, N. J., Cook, C. J., & Kilduff, L. P. (2010). Influence of postactivation potentiation on sprinting performance in professional rugby players. *Journal of Strength and Conditioning Research, 24*(3), 701-705. https://doi.org/10.1519/JSC.0b013e3181c7b68a

Birzniece, V., Nelson, A., & Ho, K. (2011). Growth hormone and physical performance. *Trends in Endocrinology & Metabolism, 22*(3), 171-178. https://doi.org/10.1016/j.tem.2011.02.005

Blanchard, J., & Sawers, S. A. (2004). The absolute bioavailability of caffeine in man. *European Journal of Clinical Pharmacology, 24*(1), 93-98. https://doi.org/10.1007/BF00613933

Bobbert, M. (1990). Drop jumping as a training method for jumping ability. *Sports Medicine, 9*(1), 7-22. https://doi.org/10.2165/00007256-199009010-00002

Botton, C. E., Radaelli, R., Wilhelm, E. N., Rech, A., Brown, L. E., & Pinto, R. S. (2016). Neuromuscular adaptations to unilateral vs. bilateral strength training in women. *Journal of Strength and Conditioning Research, 30*(7), 1924–1932. https://doi.org/10.1519/JSC.0000000000001125

Brown, I. E., & Loeb, G. (1998). Post-activation potentiation—A clue for simplifying models of muscle dynamics. *Integrative and Comparative Biology, 38*(4), 743-754. https://doi.org/10.1093/icb/38.4.743

Bružas, V., Kamandulis, S., Venckunas, T., Snieckus, A., & Mockus, P. (2018). Effects of plyometric exercise training with external weights on punching ability of experienced amateur boxers. *The Journal of Sports Medicine and Physical Fitness, 58*(3), 221-226. https://doi.org/10.23736/S0022-4707.16.06674-3

Carroll, T., Taylor, J. L., & Gandevia, S. (2017). Recovery of central and peripheral neuromuscular fatigue after exercise. *Journal of Applied Physiology*.

Sportis
Revista Técnico-Científica del Deporte Escolar, Educación Física y Psicomotricidad
Scientific Technical Journal of School Sport, Physical Education and Psychomotricity
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ISSN-e 2386-8333
E-mail: sportis.journal@udc.es Web: https://revistas.udc.es

Caskey, S. (1968). Effects of motivation on standing broad jump performance of children. *Research Quarterly, 39*(1), 54-59. https://doi.org/10.1080/10671188.1968.10616529

Chatzopoulos, D., Michailidis, C., Alexiou, K., Patikas, D., Antonopoulos, C. B., & Kotzamanidis, C. (2007). Postactivation potentiation effects after heavy resistance exercise on running speed. *Journal of Strength and Conditioning Research, 21*(4), 1278-1281. https://doi.org/ 10.1519/R-21276.1

Chiu, L., Fry, A., Weiss, L., Schilling, B., Brown, L., & Smith, S. L. (2003). Postactivation potentiation response in athletic and recreationally trained individuals. *Journal of Strength and Conditioning Research, 17*(4), 671-677. https://doi.org/10.1519/1533-4287(2003)017<0671:ppriaa>2.0.co;2

Coffey, V. G., & Hawley, J. A. (2017). The molecular bases of training adaptation. *Sports Medicine, 47*(Supplement 1), 1-20. http://doi.org/10.2165/00007256-200737090-00001

Coratella, G., Beato, M., Milanese, C., Longo, S., Limonta, E., Rampichini, S., Cé, E., Bisconti, A., Schena, F., & Esposito, F. (2018). Specific adaptations in performance and muscle architecture after weighted jump-squat vs. body mass squat jump training in recreational soccer players. *Journal of Strength and Conditioning Research, 32*, 921–929. https://doi.org/10.1519/JSC.0000000000002463

Cortis, C., Tessitore, A., D'Artibale, E., Meeusen, R., & Capranica, L. (2010). Effects of post-exercise recovery interventions on physiological, psychological, and performance parameters. *International Journal of Sports Medicine, 31*(5), 327-335. https://doi.org/10.1055/s-0030-1248242

Creekmur, C. C., Haworth, J. L., Cox, R. H., & Walsh, M. S. (2016). Effects of plyometrics performed during warm-up on 20 and 40 m sprint performance. *The*

Sportis
Revista Técnico-Científica del Deporte Escolar, Educación Física y Psicomotricidad
Scientific Technical Journal of School Sport, Physical Education and Psychomotricity
Editor: University of A Coruña. A Coruña. Spain
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Journal of Sports Medicine and Physical Fitness, 57(5), 550-555. https://doi.org/10.23736/S0022-4707.16.06227-7

Del Pozo, F. J., Alonso, J. V., Álvarez, M. V., Orr, S., & Cantarero, F. J. L. (2017). Physical fitness as an indicator of health status and its relationship to academic performance during the prepubertal period. *Health promotion perspectives*, *7*(4), 197–204. https://doi.org/10.15171/hpp.2017.35

Esformes, J. I., Cameron, N., & Bampouras, T. M. (2010). Postactivation potentiation following different modes of exercise. *Journal of Strength and Conditioning Research, 24*(7), 1911-1916. https://doi.org/10.1519/JSC.0b013e3181dc47f8

Tsimachidis, T. K., Conley, D. S., & McCawley, P. F. (2015). Postactivation potentiation enhances upper- and lower-body athletic performance in collegiate male and female athletes. *Journal of Strength and Conditioning Research, 29*(2), 336-342. https://doi.org/10.1519/JSC.0000000000000728

Gołaś, A., Maszczyk, A., Zając, A., Mikołajec, K., & Stastny, P. (2016). Optimizing post activation potentiation for explosive activities in competitive sports. *Journal of Human Kinetics, 52*, 95-106. https://doi.org/10.1515/hukin-2015-0197

Guerra Jr, M. A., Caldas, L. C., De Souza, H. L., et al. (2018). The acute effects of plyometric and sled towing stimuli with and without caffeine ingestion on vertical jump performance in professional soccer players. *Journal of the International Society of Sports Nutrition, 15*(1), 51. https://doi.org/10.1186/s12970-018-0258-3

Hancock, A. P., Sparks, K. E., & Kullman, E. L. (2015). Postactivation potentiation enhances swim performance in collegiate swimmers. *Journal of Strength and Conditioning Research, 29*(4), 912-917. https://doi.org/10.1519/JSC.0000000000000712

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Revista Técnico-Científica del Deporte Escolar, Educación Física y Psicomotricidad
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Hart, P. (2018). Multivariate analysis of vertical jump predicting health-related physical fitness performance. *American Journal of Sports Science and Medicine, 6*(4), 99-105. https://doi.org/10.12691/AJSSM-6-4-1

Hrysomallis, C. (2012). The effectiveness of resisted movement training on sprinting and jumping performance. *Journal of Strength and Conditioning Research, 26*(1), 299-306. https://doi.org/10.1519/JSC.0b013e3182185186

Hudgins, B., Scharfenberg, J., Triplett, N. T., & McBride, J. M. (2013). Relationship between jumping ability and running performance in events of varying distance. *Journal of Strength and Conditioning Research, 27*(3), 563-567. https://doi.org/10.1519/JSC.0b013e31827e136f

Iacono, A., Martone, D., & Padulo, J. (2016). Acute effects of drop-jump protocols on explosive performances of elite handball players. *Journal of Strength and Conditioning Research, 30*, 3122–3133. https://doi.org/10.1519/JSC.0000000000001393

Jones, A. (2010). Evidence-based survey of the elimination rates of ethanol from blood with applications in forensic casework. *Forensic Science International, 200*(1-3), 1-20. https://doi.org/10.1016/j.forsciint.2010.02.021

Karampatsos, B. G., Terzis, G., Polychroniou, C., & Georgiadis, G. (2013). Acute effects of jumping and sprinting on hammer throwing performance. *Journal of Physical Education and Sport, 13*(1), 3-5. https://doi.org/10.7752/jpes.2013.01001

Kim, J. G., Kim, S. B., Chung, K., & Ha, J. (2016). Vertical jump test as a functional test after anterior cruciate ligament reconstruction. *Orthopaedic Journal of Sports Medicine, 4*. https://doi.org/10.1177/2325967116S00203

Kitani, M. A., Ambussaidi, A., Al Busafi, M., Al-Hadabi, B., Sassi, R. H., Bouhlel, E., & Gmada, N. (2020). Acute effect of post-activation potentiation using drop jumps on repeated sprints combined with vertical jumps in young handball

Sportis. Revista Técnico-Científica del Deporte Escolar, Educación Física y Psicomotricidad
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players. *Isokinetics and Exercise Science, 28*(4), 1-8. https://doi.org/10.3233/IES-203185

Klavora, P. (2000). Vertical-jump tests: A critical review. *Strength and Conditioning Journal, 22*(4), 70-75. https://doi.org/10.1519/1533-4295(2000)022<0070:VJTACR>2.0.CO;2

Kobal, R., Nakamura, F. Y., Kitamura, K., Abad, C. C., Pereira, L. A., & Loturco, I. (2017). Vertical and depth jumping performance in elite athletes from different sports specialties. *Science & Sports, 32*(6), 1-8. https://doi.org/10.1016/j.scispo.2017.01.007

Lee, C. D., Jaggers, J. R., Swank, A. M., & Frost, K. L. (2018). The acute effects of dynamic and ballistic stretching on vertical jump height, force, and power. *Journal of Strength and Conditioning Research, 22*(6), 1844-1849. https://doi.org/10.1519/JSC.0b013e3181854a3d

Li, J., Soh, K. G., Loh, S., Luo, S., Bashir, M., & Yu, X. (2023). Effect of post-activation potentiation on the sports performance of athletes: A systematic review. *Journal of Human Kinetics, 52*, 95-106. https://doi.org/10.1101/2023.09.01.23294960

Liao, K. F., Nassis, G., Bishop, C., Yang, W., Bian, C., & Li, Y. (2021). Effects of unilateral vs. bilateral resistance training interventions on measures of strength, jump, liNPAPr and change of direction speed: A systematic review and meta-analysis. *Biology of Sport, 39*, 485-497. https://doi.org/10.5114/biolsport.2022.107024

Linder, E. E., Prins, J. H., Murata, N. M., Derenne, C., Morgan, C. F., & Solomon, J. R. (2010). Effects of preload 4 repetition maximum on 100-m sprint times in collegiate women. *Journal of Strength and Conditioning Research, 24*(5), 1184-1190. https://doi.org/10.1519/JSC.0b013e3181d75806

Sportis Revista Técnico-Científica del Deporte Escolar, Educación Física y Psicomotricidad
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Magkos, F., & Kavouras, S. A. (2005). Caffeine use in sports, pharmacokinetics in man, and cellular mechanisms of action. *Critical Reviews in Food Science and Nutrition, 45*(7-8), 535-562. https://doi.org/10.1080/1040-830491379245

Makaruk, H., Winchester, J. B., Sadowski, J., Czaplicki, A., & Sacewicz, T. (2011). Effects of unilateral and bilateral plyometric training on power and jumping ability in women. *Journal of Strength and Conditioning Research, 25*(12), 3311-3318. https://doi.org/10.1519/JSC.0b013e318215fa33

Markovic, G., & Mikulic, P. (2010). Neuro-musculoskeletal and performance adaptations to lower-extremity plyometric training. *Sports Medicine, 40*(10), 859-895. https://doi.org/10.2165/11318370-000000000-00000

Massuca, L. M., & Branco, B. H. M. (2016). Physical fitness and anthropometric characteristics of male handball players of different ages. *Journal of Sports Medicine and Physical Fitness, 56*(5), 541-551. https://doi.org/10.2174/1875399X00902010022

McElveen, M. T., Riemann, B. L., & Davies, G. J. (2010). Bilateral comparison of propulsion mechanics during single-leg vertical jumping. *Journal of Strength and Conditioning Research, 24*(2), 375-381. https://doi.org/10.1519/JSC.0b013e3181c06e0b

McEwan, D., Martin Ginis, K. A., & Ginis, S. (2019). The effectiveness of psychological interventions in improving sports performance: A meta-analysis. *Journal of Sport and Exercise Psychology, 41*(4), 338-350. https://doi.org/10.1007/s40279-023-01931-z

Menzel, H., Chagas, M., Szmuchrowski, L., Araujo, S., Campos, C., & Giannetti, M. (2010). Usefulness of the Jump-and-Reach Test in assessment of vertical jump performance. *Perceptual and Motor Skills, 110*(1), 150-158. https://doi.org/10.2466/pms.110.1.150-158

Editor: University of A Coruña. A Coruña. Spain
ISSN-e 2386-8333
E-mail: sportis.journal@udc.es Web: https://revistas.udc.es

Mota, G., & Marocolo, M. (2022). Editorial: Ergogenic aids: Physiological and performance responses. *Frontiers in Sports and Active Living, 4.* https://doi.org/10.3389/fspor.2022.902024

Nelson, H., Bosak, A., Lowell, R., Ziebell, B., Sanders, R., Feister, J., & Phillips, M. (2018). An assessment of a 15 vs. 30 second recovery period on vertical jump performance: 3246 board #115 June 2 8:00 AM - 9:30 AM. *Medicine and Science in Sports and Exercise, 50*, 801. https://doi.org/10.1249/01.MSS.0000538638.69828.3E

Padulo, J., Tabben, M., Ardigò, L., Ionel, M., Popa, C., Gevat, C., Zagatto, A., & Dello Iacono, A. (2015). Repeated sprint ability related to recovery time in young soccer players. *Research in Sports Medicine, 23*, 412-423. https://doi.org/10.1080/15438627.2015.1076419

Pennell, A., Yee, N., Conforti, C., Yau, K., & Brian, A. (2021). Standing long jump performance in youth with visual impairments: A multidimensional examination. *International Journal of Environmental Research and Public Health, 18.* https://doi.org/10.3390/ijerph18189742

Pérez-Castilla, A., García-Ramos, A., Janicijevic, D., Miras-Moreno, S., De la Cruz, J. C., Rojas, F., & Cepero, M. (2021). Unilateral or bilateral standing broad jumps: Which jump type provides inter-limb asymmetries with a higher reliability? *Journal of Sports Science & Medicine, 20*(2), 317-327. https://doi.org/10.52082/jssm.2021.317

Piper, A., Joubert, D. P., Jones, E. J., & Whitehead, M. (2020). Comparison of post-activation potentiating stimuli on jump and sprint performance. *International Journal of Exercise Science, 13*(4), 539-553.

Rahman, Z. A. (2021). Reliability, validity, and norm references of standing broad jump. *Journal of Physical Education and Sport, 21*(3), 1078-1085. https://doi.org/10.47059/revistageintec.v11i3.2014

Sportis
Revista Técnico-Científica del Deporte Escolar, Educación Física y Psicomotricidad
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Read, M., & Cisar, C. (2001). The influence of varied rest interval lengths on depth jump performance. *Journal of Strength and Conditioning Research, 15*, 279-283. https://doi.org/10.1519/1533-4287(2001)015<0279:TIOVRI>2.0.CO;2

Santos, E. J., Janeira, M. A., & Izquierdo, M. (2016). Neuromuscular adaptations in vertical jump performance in youth basketball players. *Journal of Strength and Conditioning Research, 30*(3), 808-818. https://doi.org/10.1371/journal.pone.0283026

Šarabon, N., Marušič, J., Marković, G., & Maffiuletti, N. A. (2020). Influence of the warm-up duration on physical performance in young soccer players. *Journal of Sports Science & Medicine, 19*(1), 188-194. https://doi.org/10.5114/biolsport.2019.81114

Schubert, M., & Astorino, T. (2013). A systematic review of the efficacy of ergogenic aids for improving running performance. *Journal of Strength and Conditioning Research, 27*(6), 1699-1707. https://doi.org/10.1519/JSC.0b013e31826cad24

Seitz, L. B., Mina, M. A., & Haff, G. G. (2016). Postactivation potentiation of horizontal jump performance across multiple sets of a contrast protocol. *Journal of Strength and Conditioning Research, 30*(10), 2733-2740. https://doi.org/10.1519/JSC.0000000000001383

Seitz, L., & Haff, G. (2016). Factors modulating post-activation potentiation of jump, sprint, throw, and upper-body ballistic performances: A systematic review with meta-analysis. *Sports Medicine, 46*, 231-240. https://doi.org/10.1007/s40279-015-0415-7

Stålbom, M., Jonsson Holm, D., Cronin, J., & Keogh, J. (2007). Reliability of kinematics and kinetics associated with horizontal single leg drop jump assessment: A brief report. *Journal of Sports Science & Medicine, 6*(2), 261-264.

Sportis
Revista Técnico-Científica del Deporte Escolar, Educación Física y Psicomotricidad
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Stankovic, M., Djordjevic, D., Trajkovic, N. *et al.* Effects of High-Intensity Interval Training (HIIT) on Physical Performance in Female Team Sports: A Systematic Review. *Sports Med - Open* 9, 78 (2023). https://doi.org/10.1186/s40798-023-00623-2

Sue, R., Adams, K., & DeBeliso, M. (2016). Optimal timing for post-activation potentiation in women collegiate volleyball players. *Sports, 4*(2), 27. https://doi.org/10.3390/sports4020027

Terzis, G., Karampatsos, G., Kyriazis, T., Kavouras, S. A., & Georgiadis, G. (2012). Acute effects of countermovement jumping and sprinting on shot put performance. *Journal of strength and conditioning research*, *26*(3), 684–690. https://doi.org/10.1519/JSC.0b013e31822a5d15

Terzis, G., Spengos, K., Karampatsos, G., Manta, P., & Georgiadis, G. (2009). Acute effect of drop jumping on throwing performance. *Journal of strength and conditioning research*, *23*(9), 2592–2597. https://doi.org/10.1519/JSC.0b013e3181b1b1a

Thein, L., Applegate, J. M., & Landry, G. L. (1995). Ergogenic aids. *Physical Therapy, 75*(5), 426-439. https://doi.org/10.1093/ptj/75.5.426

Thomas, E., Petrigna, L., Tabacchi, G., Teixeira, E., Pajaujiene, S., Sturm, D. J., Sahin, F. N., Gómez-López, M., Pausic, J., Paoli, A., Alesi, M., & Bianco, A. (2020). Percentile values of the standing broad jump in children and adolescents aged 6-18 years old. *European journal of translational myology*, *30*(2), 9050. https://doi.org/10.4081/ejtm.2019.9050

Tomkinson, G., Kaster, T., Dooley, F. L., Fitzgerald, J., Annandale, M., Ferrar, K., Lang, J., & Smith, J. J. (2020). Temporal trends in the standing broad jump performance of 10,940,801 children and adolescents between 1960 and 2017. *Sports Medicine, 51*, 531-548. https://doi.org/10.1007/s40279-020-01394-6

Sportis
Revista Técnico-Científica del Deporte Escolar, Educación Física y Psicomotricidad
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Tounsi, M., Aouichaoui, C., Elloumi, M., Dogui, M., Tabka, Z., & Trabelsi, Y. (2015). Reference values of vertical jumping performances in healthy Tunisian adolescents. *Annals of Human Biology, 42*(2), 117-125. https://doi.org/10.3109/03014460.2014.926989

Tsimachidis, C., Patikas, D., Galazoulas, C., Bassa, E., & Kotzamanidis, C. (2013). The post-activation potentiation effect on sprint performance after combined resistance/sprint training in junior basketball players. *Journal of Sports Sciences, 31*(10), 1117-1124. https://doi.org/10.1080/02640414.2013.771817

Turner, A., Bellhouse, S., Kilduff, L., & Russell, M. (2015). Postactivation potentiation of sprint acceleration performance using plyometric exercise. *Journal of Strength and Conditioning Research, 29*, 343–350. https://doi.org/10.1519/JSC.0000000000000647

Vanezis, A., & Lees, A. (2005). A biomechanical analysis of good and poor performers of the vertical jump. *Ergonomics, 48*(11-14), 1594-1603. https://doi.org/10.1080/00140130500101262

Van Raalte, J. L., Cornelius, A. E., Andrews, S., Diehl, N. S., & Brewer, B. W. (2015). Mental health referral for student-athletes: Web-based education and training. *Journal of Clinical Sport Psychology*, *9*(3), 197-212. https:// doi.org/ 10.1123/jcsp.2015-0011

Vieira, A., Blazevich, A. J., DA Costa, A. S., Tufano, J. J., & Bottaro, M. (2021). Validity and Test-retest Reliability of the Jumpo App for Jump Performance Measurement. *International journal of exercise science*, *14*(7), 677–686.

Wang, H., Hong, X., Li, S., & Wang, Y. (2017). Oxygen supplementation improves protein milieu supportive of protein synthesis and antioxidant function in the cortex of Alzheimer's disease model mice—a quantitative proteomic study. *Journal of Molecular Neuroscience*, 63, 243-253. https://doi.org/10.1007/s12031-017-0975-0

Editor: University of A Coruña. A Coruña. Spain
ISSN-e 2386-8333
E-mail: sportis.journal@udc.es Web: https://revistas.udc.es

Yang, L. (2009). Kinetic model of the human jumping process. *Journal of Transport Information and Safety, 27*(5), 27-36. https://doi.org/10.3963/j.issn.1674-4861.2009.02.013

Zaggelidis, G., Lazaridis, S., Malkogiorgos, A., & Mavrovouniotis, F. (2012). Differences in vertical jumping performance between untrained males and advanced Greek judokas. *Annals of Botany, 8*, 85-90.