International Journal of Health, Exercise, and Sport Sciences
(IJOSS) ISSN: 3023-8382

RESEARCH ARTICLE / Araştırma Makalesi **Open Access/**Açık Erişim

The Effect Of Different Pape Protocols in The Warm-Up Period of Basketball Players on Performance

Basketbolcularda Isınma Periyodunda Uygulanan Farklı Pape Protokollerinin Performansa Etkisi

Ahmet Yalçın[1], Barış Baydemir[2*]

***Correspondence:**
Barış Baydemir
barisbaydemir@hotmail.com
Çanakkale 18 Mart University.

[1] Avrasya Sports Centre, İstanbul, Türkiye,
Orcid: 0000-0002-3319-8696,
ylcnahmt@gmail.com

[2] Çanakkale Onsekiz Mart University, Faculty of Sports Sciences, Department of Coaching Education, Çanakkale, Türkiye,
Orcid: 0000-0002-8653-0664,
barisbaydemir@hotmail.com

https:/doi.org/ 10.5281/

Received / Gönderim: 30.05.2024

Accepted / Kabul: 20.12.2024

Published / Yayın: 28.02.2025

Volume 2, Issue 1, February, 2025

Abstract

The aim of this study is the result of the acute effects of back squat exercise applied against resistance as a PAPE (post activation performance enhancement) protocol on the athletic performance of athletes. 60 athletes playing basketball in the U16 category in different sports clubs participated in the study (age: 15.38±,715 years; height: 1.77±.06 cm; weight: 68±12 kg; BMI: 21.71±3.11). Vertical jump and agility performances of the athletes were measured at the pre-test, 4th, 8th and 12th minutes, and PAPE was applied as 1 set x 4 repetitions with 85% of one maximal repetition (1RM) of athletes. According to the obtained; It was revealed that there was a difference as observed in the vertical direction and speed performance of the athletes following the performance enhancement rules after this activation ($p<0.05$). In conclusion, it has been determined that PAPE (Post-activation performance enhancement) applications enhance agility and vertical jump performance in basketball players. The increase in performance reaches its peak at the 12th minute, accompanied by elevated heart rate and lactate levels. Considering the most effective time period for the PAPE protocol, which is taken into account, incorporating these exercises into the warm-up period can also have a positive impact on match performance.

Keywords Basketball, PAPE, Warm-up, Performance, Vertical Jump, Agility.

Öz

Bu çalışmanın amacı, PAPE (post activation performance enhancement) protokolü olarak dirence karşı uygulanan back squat egzersizinin sporcuların atletik performansları üzerine akut etkilerinin araştırılmasıdır. Çalışmaya farklı spor kulüplerinde U16 kategorisinde basketbol oynayan 60 sporcu katılmıştır (yaş: 15,38±,715 yıl; boy: 1,77±,06 cm; kilo: 68±12 kg; BKİ: 21,71±3,11). Sporcuların dikey sıçrama ve çeviklik performansları protokol öncesinde öntest olarak ölçüldükten sonra PAPE protokolü olarak sporcuların bir maksimal tekrarlarının (1RM) %85'i ile 1 set x 4 tekrar back squat egzersizi olarak uygulanmıştır. Ardından 4., 8. ve 12. dakikalarda tekrar dikey sıçrama ve çeviklik testleri uygulanmıştır. Elde edilen bulgulara göre; bu araştırmada aktivasyon sonrası performans geliştirme protokolü sonrasında sporcuların dikey sıçrama ve çeviklik performanslarında, kalp atım hızı ve laktat değerlerinde istatistiksel olarak anlamlı bir fark olduğu ortaya konmuştur ($p<0.05$). Sonuç olarak, PAPE uygulamalarının basketbolcularda çeviklik ve dikey sıçrama performansını akut olarak artırdığı tespit edilmiştir. Süreler arasındaki artışın 12. dakikada en anlamlı ve kalp atım hızı ile laktat değerlerinin en üst seviyede olduğu görülmüştür. Basketbolcuların ısınma çalışmalarına ek olarak uygulanan PAPE protokolünün en etkili olduğu süre dikkate alınarak ısınma periyodunda bu çalışmalara yer verilmesi maç performansını da olumlu etkileyeceği söylenebilir.

Anahtar Kelimeler Basketbol, PAPE, Isınma, Performans, Dikey Sıçrama, Çeviklik

Introduction

Nowadays, performance differences in competitive sports can greatly affect the success of an athlete and a team. Therefore, coaches and athletes try to implement advanced training strategies to further improve athletic performance. Basketball is a sport with a very high competitive pace. Coaches and athletes follow various warm-up protocols to improve their performance.

Warm-up, is a set of movements that maximizes performance during competition or training and it is performed in order to prevent the risk of an injury. It is stated that stretching movements performed during the warm-up phase and before a challenging exercise, increase the flexibility and range of motion in the joints. Depending on this approach, it is a matter of debate that stretching movements performed before challenging and short-term exercises may negatively affect performance (Baydemir et al., 2016). It has been stated that the loss of strength that occurs due to stretching exercises during sportive performance may be related to the motor control strategy of the muscle or mechanical factors including viscoelastic properties or neural factors such as sensitivity in reflexes (Avloniti et al., 2016).

There are many studies investigating the effects of warming up on sportive performance. In a meta-analysis study, it was concluded that warm-up practices caused a 79 percent increase in performance (Fradkin et al., 2010). The warm-up that aims to maximize the performance includes stretching, submaximal aerobic activity and branch-specific movements. Increased blood rate and connective and muscle tissue temperature after warming up are considered as factors that have a positive effect on performance. As the viscosity of the muscle decreases, mechanical efficiency, elasticity and muscle contraction speed, nerve conduction speed, and the amount of oxygen coming to the muscle increase. Improvements in coordination and a decrease in the resistance in the vascular bed are also observed. The increase in temperature in the muscles helps the gamma nerve fibers to activate in the event of muscle tension and relax the muscle by reducing the sensitivity of the muscle spindles. The increase in metabolic rate and muscle makes it possible to become stronger and able to do more effective work. However, it should not be ignored that there are different approaches to the effect of warming up on sportive performance (Silva et al., 2018).

Post-Activation Performance Enhancement (PAPE), applied in the warm-up phase, has become a protocol applied to achieve acute increases in athletic performance after voluntary conditioning activity (Blazevich and Babault, 2019). PAPE, typically occurs after strength-based movements that exceed 85% or more of the maximum weight a person can lift in one repetition, known as conditioning activity (Lockie et al., 2018). Because the relationship between fatigue and reinforcement is necessary for PAPE to occur, resting periods between conditioning activity and performance evaluation activities are an important factor (Marshall et al., 2019). In this case, the amount of force a muscle can produce after initial training is the result of the net balance between fatigue and muscle strengthening (Docherty et al., 2007; Rassier et al., 2000). Optimum performance occurs when fatigue decreases and reinforcement continues (Hodgson et al., 2005). PAPE is a phenomenon defined as an acute increase in power output caused by voluntary contraction of skeletal muscles (Robbins et al., 2005). The performance of skeletal muscles at any given moment depends on the contraction history of the same muscles, i.e. their previous contractions of the respective muscles. The most likely consequence of previous muscle contractions is fatigue, which can negatively impact performance (Sale, 2002). However, PAPE positively affects performance by providing maximal or near-maximal voluntary contractions, that is, by increasing peak force and force generation rate along with Conditioning Activity (Tillin and Bishop, 2009).

The PAPE protocol appears as an acute increase in muscle performance after a conditioning activity. It has been stated that following a biomechanically similar movement performed against resistance leads to acute increases in targeted performance (Kilduff et al., 2007; Gepfert et al., 2020). On the other hand, there are studies in the literature reporting that the PAPE protocol does not have positive effects on performance increase (Padulo et al., 2015, Sygulla and Fountaine, 2014). Different result reports in the literature have created the need for a deeper research on this subject. For this reason, it was aimed to investigate the effects of the PAPE protocol added to the warm-up phase on athletic performance in basketball players and in what time period it reached the maximal level.

Material and Methods

Research Model

In this study, the effects of different PAPE protocols applied during the warm-up period on basketball players were examined. Height, body weight, Body Mass Index (BMI), maximal strength (1RM), relative strength, lactate measurements and instantaneous heart rate values of the study participants were taken. In addition, Countermovement Jump (CMJ) and 505 Agility tests were applied to the participants both before the PAPE protocol and 4, 8 and 12 minutes after the protocol was implemented. Countermovement Jump and 505 Agility tests of the athletes after 5-7 minute warm-up exercises specific to Basketball have been measured and compared in the given order; first measurement (pre-test), then the second measurement (4th minute) followed by 85% 1RM-4 repetitions Back Squat (PAPE), third measurement (8th minute) and fourth measurement (12th minute). The hypothesis of the study was determined as 85% 1RM-4 Repeat Back Squat exercise had a positive effect on the athletes' Countermovement Jump and 505 Agility test values.

Research Group

60 athletes from the U16 age category, who play basketball in different sports clubs in Istanbul, participated in the study. Participants of the study were determined by purposeful sampling method. The research was designed in accordance with the Declaration of Helsinki and ethics committee permission was obtained.

Data Collection Tools

Height, body weight, Body Mass Index (BMI), maximal strength (1RM), relative strength, lactate measurement and instantaneous heart rate values of the basketball players participating in the study were taken and Countermovement Jump (CMJ) and 505 Agility tests were applied.

Anthropometric Measurements

Height measurements of basketball players were made without socks using SECA (Germany) brand height measuring equipment with an accuracy of 0.1m. The body weights of basketball players were measured with a SECA (Germany) brand electronic scale with a sensitivity of 0.5 kg. To determine the Body Mass Index, the formula "Body Mass Index (BMI) = Body Weight (kg) / Height2 (m2) was used (Benazeera, 2014).

Maximal Force (1RM)

It is the maximum weight that can be lifted at one time within the joint range of motion. Since the sample consisted of young athletes, the indirect method Brzycki method was used to avoid any risk factors. The data obtained by lifting the back squat exercise at

maximum repetitions with a weight that the athlete could lift relatively easily was noted, and then the formula "1RM=100 x Weight / [102.78-(2.78 x Number of Reps)] was used (Brzycki, 1993).

Lactate Measurement

Lactate Scout Meter (EKF Diagnostics, England) was used to monitor the athletes' fatigue levels by measuring their lactate values between tests. After completing the 5-7 minute warm-up exercises specific to basketball at Şehit Onbaşı Murat Şengöz İHAL Sports Hall, the basketball players were given Countermovement Jump (CMJ) and 505 Agility exercises in the 4th, 8th and 12th minutes after the protocol was applied (McLaren et al., 2017). After the test, lactate measurement was made.

Determining Heart Rate

During the exercises and tests, the athletes' instantaneous heart rates were monitored using the Polar H10 Heart Rate Sensor (Finland). During the practice period at Şehit Onbaşı Murat Şengöz İHAL Sports Hall, the maximum heart rate counts and percentages of the physical performances of the basketball players were monitored and their training loads were kept under control.

Relative Force

It is the highest force that the athlete can produce against their own body weight. It indicates the force it can exert for every 1 kg. Using the following formula: "Relative Force = Weight Lifted / Body Weight", basketball players were made to perform back squat exercises (Bautista et al., 2022).

Countermovement Jump (CMJ)

It is a vertical jump test performed by the athlete squatting and then jumping as high as possible. It is used to measure explosive lower body strength. Compared with five different vertical jump tests, CMJ was reported to have the highest reliability among all tests with a value of .98 and the explosive power factor to show the greatest factorial validity with a value of .87 (Markovic et al., 2004). In a study comparing the MyJump application with the force platform, the intra-class correlation coefficient was reported as .997 and the validity assessment was reported as .995 (Balsalobre-Fernández et al., 2015). CMJ values were measured with the iPhone application MyJump, which was developed to calculate jumping height based on the flight duration using the fast video recording feature. CMJ was performed with the hands on the hips to prevent the athletes from generating power from arm swing. Athletes were given two tries and their best scores were taken as basis.

505 Agility Test

It was first discovered by Draper and Lancaster in 1985 to measure agility in the horizontal plane (Draper and Lancaster, 1985). It is used to measure agility and ability to change direction. In the study, it was reported that the test was valid and reliable (Stewart et al., 2014). Performance measurements of the basketball players were conducted with the SE-320 Wireless Photocell Stopwatch (Turkey) in the presence of assistants using strips marked on the ground at Şehit Onbaşı Murat Şengöz İHAL Sports Hall. After two attempts, the best time score was recorded.

PAPE Protocol

The PAPE protocol appears as an acute increase in athletic performance after a conditioning activity. It is the increase in performance performed in biomechanically

similar movement sequences following a resistance exercise. When the studies in the literature are examined, the PAPE protocol in the research was applied as a 1 set x 4 repetition back squat exercise with 85% of the athletes' maximal repetitions (1RM) (Blazevich and Babault 2019; Gepfert et al., 2020). Measurements were taken by applying Countermovement Jump and 505 Agility Tests at the 4th, 8th and 12th minutes following the exercise. Meanwhile, the performance times and physiological parameters of the athletes were monitored, heart rate with the Heart Rate Sensor (Polar H10), and lactate values with the Lactate Scout Meter.

Analysis of Data

SPSS analysis program was used to determine the results of the data obtained by investigating the acute effects of different PAPE protocols applied during the warm-up period on basketball players' performance. Repeated Measures ANOVA Test was performed. The significance level was determined as ($p<0.05$).

Results

Table 1 Evaluation of Participants' Introductory Information and Some Measurements

	Average	SD	Min.	Max.
Age (years)	15,38	,715	14	16
Years of Exercise (years)	2,52	1,228	1	5
Height (m)	1,77	,06	1,59	1,91
Weight (kg)	68	12	47	96
BMI	21,71	3,11	16,37	29,05
Maximal Force (kg)	56	18	30	100
Relative Force (Maximal weight lifted/body weight)	,82,19	,19	,39	1,37

Table 1 presents the demographic information and some measurements of the participants. The average age of the participants is 15.38±0.715 years, with the youngest being 14 and the oldest 16 years old. The average duration of exercise is 2.52±1.228 years, ranging from 1 to 5 years. The average height is 1.77±0.06 m, and the average weight is 68±12 kg. The body mass index (BMI) has an average of 21.71±3.11. The average maximal force is 56±18 kg, while the relative force (maximal weight lifted/body weight) is calculated as 0.82±0.19, ranging from a minimum of 0.39 to a maximum of 1.37

Table 2 Repeated Measures ANOVA Results of Pre-Test, 2nd Measurement, 3rd Measurement and 4th Measurement Values of Basketball Players

		Test Time				
	Group	Pre-test	2nd Measurement (4th minute)	3rd Measurement (8th minute)	4th Measurement (12th minute)	p	Difference
Countermovement Jump (cm)	60	37,59±5,51	38,78±5,85	39,09±5,57	40,48±6,23	0,000*	1-2 1-3 1-4
505 Agility Test (sec)	60	2,73±0,20	2,73±0,22	2,70±0,22	2,66±0,22	0,000*	1-4 2-4 3-4
Heart Rate (BPM)	60	164,18±1,24	172,15±1,21	176,93±1,24	186,11±1,10	0,000*	1-2 1-3 1-4
Lactat Measurement (mmol)	60	2,80±0,68	4,80±0,68	6,30±0,68	7,80±0,68	0,000*	1-2 1-3 1-4

**p<0,05, **1 = Pre-test, 2 = 2nd Measurement, 3 = 3rd Measurement, 4 = 4th Measurement*

It was revealed that there was a significant difference between the values taken before the PAPE protocol in basketball players and the values taken at the fourth, eighth and twelfth minutes after the Countermovement Jump application ($p<0.05$). It was determined that the most significant difference between the values was between the pre-test and the 4th measurement (12th minute). Moreover, there was significant increase between second measurement and fourth measurement as well as third measurement and fourth measurement ($p<0,05$).

While there was no significant difference between the values taken before the PAPE protocol in basketball players and the values taken at the fourth and eighth minutes after the 505 agility test application ($p>0.05$), it was revealed that there was a significant difference between the values taken at the twelfth minute ($p<0.05$). It was found that the most significant difference between the values was between the 2nd measurement (fourth minute) and the 4th measurement (twelfth minute). However, there is a significant increase between the third and fourth measurements as well ($p<0.05$).

It was revealed that there was a significant difference in the heart rate values of basketball players before the PAPE protocol between the values taken before and at the fourth, eighth and twelfth minutes after the application ($p <0.05$). It was found that the most significant difference between the values was between the pre-test and the 4th measurement (12th minute). However, there was significant increase between the second measurement and third measurement, second measurement and fourth measurement and third measurement and fourth measurement.

It was revealed that the difference between the lactate values of basketball players before the PAPE protocol and the values taken before and at the fourth, eighth and twelfth minutes after the application were significant ($p<0.05$). It was found that the most significant difference between the values was between the pre-test and the 4th measurement (12th minute).

Discussion and conclusion

This research was conducted to determine the effects of the PAPE protocol added to the warm-up phase on athletic performance in basketball players and the time period in which it reached maximal level. The age of the athletes that participated in the research was 15,38±,715, while their exercise years were determined as 2,52±1,228, their height was 1,77±,06, their body weight was 68±12, their BMI was 21,71±3,11, their maximal force was 56±18 and their relative force was 82±,19 (Table 1). It was determined that the difference in Countermovement Jump (CMJ) values in basketball players was statistically significant. Accordingly, the Countermovement Jump (CMJ) values of basketball players increased in the pre-test, 4th minute, 8th minute and 12th minute, and the highest value was detected at the 12th minute. In the 505 Agility Test, it was determined that there was a statistically significant difference according to the measurements. It was also determined that the heart rate values of basketball players in the 12th minute were higher than the heart rate values in the pre-test, 4th minute and 8th minute. This significant difference between the aforementioned values also shows that heart rate values in basketball players increase over time. It was determined that there was a statistically significant difference in the lactate values of basketball players according to the measurements. Accordingly, it was determined that the lactate values of the participants at the 12th minute were higher than the lactate values at the pre-test, 4th minute and 8th minute. This significant difference between these values also shows that the lactate values of the participants increased over time (Table 2).

The PAPE protocol appears as an acute increase in athletic performance after a conditioning activity. Following a resistance training, the muscle is both fatigued and

active, and in this case the muscle performance depends on the balance between these two factors. In their study, Kilduff et al. (2007) stated that explosive movement performance increased significantly after an 8-minute recovery period following resistance trainings. In their study, Tsimachidis et al. (2013) examined the effects of a back squat exercise consisting of 5 sets, in which the mentioned recovery period was performed between each set. It was concluded that the applied protocol increased both power and sprint performance. This study stated that the post-activation performance enhancement effect on sprint performance in basketball players who had not done resistance training before, emerged after a ten-week resistance and sprint combination training program.

In their study on basketball players, Xie et al., (2022) examined the acute effects of two different conditioning methods on vertical jump and 30-meter sprint performance. The first group of participants, who were divided into two groups, performed flywheel eccentric exercise as a conditioning activity, consisting of 3 sets of 6 repetitions at low, medium and high intensities; while the second group performed the barbell back half squat exercise consisting of 3 sets of 5 repetitions at low (40% 1RM), medium (60% 1RM) and high (80% 1RM) intensities. Countermovement Jump and 30 meter sprint tests were applied after 3, 6, 9 and 12 minutes. As a result of the research, it was reported that neither method provided a significant PAPE effect, but the flywheel eccentric exercise had a better effect on vertical jump performance. Eken et al., (2022) aimed to compare the results of motoric performance tests of three different PAPE protocols applied at two different times of the day in their study with 32 basketball players with at least 2 years of training age. According to the findings of the study, it was reported that application of the protocols in the evening showed a higher increase in upper extremity performance compared to the application in the morning. Researchers have reported that using basketball-specific PAPE methods in the first part of training programs can provide specific recommendations to basketball coaches. In the study conducted by Dello et al. (2016), basketball players and handball players were included. In the study conducted to investigate the effects of the post-activation performance improvement protocol on the explosive activities of athletes, it was reported that a single-leg jumping exercise consisting of 5 sets was applied as the PAPE method. As a result of the research, it was stated that there was a negative effect on the explosive performances of the athletes whose Countermovement Jump and 20 meter sprint performances were measured. Sixteen professional basketball players participated in Gepfert et al. (2020) study to determine whether resistant and supported conditioning activity corresponding to 5% of body mass increases movement performance in basketball-specific sliding steps. In the study, statistically significant results were reported in the performance of basketball players with supported conditioning activity corresponding to 5% of body weight. The purpose of the study conducted by Zagatto et al. (2022) was reported to be to investigate the emergence of post-activation performance improvement after fall jumping and sled pulling and its effects on sprint ability. As a result of this study conducted with young basketball players, it was reported that sled pulling exercises had no effect on repeated sprint ability, but drop jumps had a positive effect on the stated performance. It has been stated that similar fatigue levels are reached after both conditioning activities and that drop jumps can be used during sprints to create a PAPE effect in young basketball players. As a result of their study, Gabbet et al. (2008) found that the fact that the athletes applied two different dynamic warm-up protocols did not create a statistically significant difference in terms of basketball players' test results on running by chaning directions, sprints, vertical jumps and reactive agility. Moreover, his study determined that the warm-up variations that include closed skill and opened skill movements performed relatively similar and that these warm-up variations can be used in team sports. In the

study conducted by Holt and Lambourne (2008), they evaluated the vertical jump performances of 64 athletes after dynamic warm-up protocols designed in three different ways by applying the static warm-up method and stated that the vertical jump performance achieved after the static warm-up protocol was lower than the other warm-up protocol applied.

When the studies conducted in other branches are examined, Needham et al. (2009) found in their study that, the vertical jump performance achieved after the football players were given three different warm-up variations and various resting durations, who then applied the warm-up protocol that consisted of ten meters - thirty meters speed performance and dynamic warm-ups with the evaluation of vertical jumps + eight squats that are equal to twenty percent of the players' body weights had better results compared to static warm-ups and dynamic warm-ups, whereas the same results were not found in terms of sprint performance. In another study conducted by Chen et al., (2013) with volleyball players, it was reported that the athletes, whose jumping performance was evaluated after the drop jump exercise, reached the highest performance increase 2 minutes after the pre-stimulating exercise. Berriel et al., (2022) conducted a study with volleyball athletes and investigated the effects of post-activation performance strengthening protocol on vertical jump performance. In this study, the participants, consisting of sixteen professional volleyball players, were divided into two groups. The first group only applied plyometric training in addition to volleyball training, and the second group applied plyometric training and post-activation performance enhancement protocol in addition to volleyball training. As a result of the research, it was reported that the post-activation performance strengthening protocol applied in addition to technical and tactical training in volleyball had a positive effect on vertical jump height. In the study conducted by Tseng et al., (2021), it was aimed to examine the effects of eccentric loading versus traditional resistance loading on post-activation performance increase. Sixteen male volleyball players participated in the research. The eccentric loading group performed the half squat exercise consisting of 3 sets of 4 repetitions (eccentric 105% 1RM, concentric 80% 1RM), and the traditional resistance loading group performed the half squat exercise consisting of 3 sets of 5 repetitions (eccentric and concentric 85% 1RM). Two-way repeated measures variance was used to analyze the data. As a result of the study, it was reported that there was no difference between the two methods when the Countermovement Jump exercise was evaluated. Researchers have proposed the eccentric loading protocol to overcome fatigue.

McLaren et al., (2017) examined the acute effects of 3 sets of resisted back squat exercise at 70% of 1 repetition maximum (1RM) in a subsequent 4-meter sprint series, followed by an 8-minute rest period. They reported significant performance gains in 3 sprints following conditioning contraction and concluded that this effect was sustainable for up to 11 minutes following resistance back squat exercise. On the other hand, Sygulla and Fountaine (2014) stated that the PAPE protocol applied in their study did not have any effect on the acute performances of the athletes (Padulo et al., 2015). Similarly, in another study conducted with young athletes in handball and basketball branches, there was a significant decrease in the vertical jump and running performances of the athletes, and it was recommended that the protocols be used cautiously. When the literature is examined, there is no single conclusion about the optimal acute load and recovery time and intensity for performance increase. Different results regarding the PAPE protocol have been reported in the literature. As a result, it can be said that this situation is due to the limitations in the sample sizes of the studies and the differences in the training ages and genders of the athletes.

As a result, it has been determined that PAPE applications increase agility and vertical jump performance in basketball players. It was observed that the increase

between periods reached the best level at the 12th minute and heart rate and lactate values were at their highest level. Considering the period in which the PAPE protocol applied in addition to the warm-up exercises of basketball players is most effective, it can be said that including these exercises in the warm-up period will positively affect match performance. It is recommended that coaches and trainers use these methods in basketball training and pre-match warm-ups because it may have acute effects on the performance of athletes

Kısaltmalar / Abbreviations

F Frekans
N Sample size (Örneklem büyüklüğü)
$\bar{X}$: Mean (Ortalama)
Ss Standard deviation (SD) (Standart sapma)
F F-ratio (ANOVA test statistic) (F değeri)
P P-value (Anlamlılık değeri)

Beyanlar / Declarations

Etik Onay ve Katılım Onayı / Ethics approval and consent to participate

Bu çalışmanın hazırlanma ve yazım sürecinde "Yükseköğretim Kurumları Bilimsel Araştırma ve Yayın Etiği Yönergesi" kapsamında bilimsel, etik ve alıntı kurallarına uyulmuş olup; toplanan veriler üzerinde herhangi bir tahrifat yapılmamış ve bu çalışma herhangi başka bir akademik yayın ortamına değerlendirme için gönderilmemiştir. Makale ile ilgili doğabilecek her türlü ihlallerde sorumluluk yazara aittir. Bu çalışmanın başlatılabilmesi için, Çanakkale Onsekiz Mart Üniversitesi Klinik Araştırmalar Etik Kurulu'ndan onay alınmıştır (Onay Numarası: 30.09.2021, 17/21)

In the preparation and writing process of this study, scientific, ethical, and citation principles outlined in the "Directive on Scientific Research and Publication Ethics of Higher Education Institutions" have been strictly followed. No falsification has been made on the collected data, and this study has not been submitted to any other academic publication medium for evaluation. The author assumes full responsibility for any potential violations related to the article. Approval was received from Çanakkale Onsekiz Mart University Clinical Research Ethics Committee (Approval Number: 30.09.2021, 17/21).

Veri Ve Materyal Erişilebilirliği / Availability of data and material

Bu çalışmanın bulgularını destekleyen veriler, makul talepler üzerine sorumlu yazardan temin edilebilir. Veri seti yalnızca akademik amaçlar için erişilebilir olacak ve verilerin herhangi bir kullanımı, orijinal çalışmayı referans gösterecek ve katılımcıların gizliliğini koruyacaktır.

The data that support the findings of this study are available from the corresponding author upon reasonable request. The dataset will be accessible only for academic purposes, and any use of the data will recognize the original study and maintain the confdentiality of the participants.

Çıkar Çatışması / Competing interests

Yazarlar, bu makalede sunulan çalışmayı etkileyebilecek herhangi bir çıkar çatışması veya kişisel ilişkiye sahip olmadıklarını beyan etmektedirler.

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Fon Desteği / Funding

Bu çalışma, Çanakkale Onsekiz Mart Üniversitesi Bilimsel Araştırma Koordinasyon Birimi tarafından desteklenmiştir (Proje No: TYL-2022-3853).

This study was supported by Çanakkale Onsekiz Mart University Scientific Research Coordination Office (Project No: TYL-2022-3853).

Yazar Katkıları / Author contributions

Çalışmanın tasarımı ve planlanması: A.Y., B.B.; Veri toplama, analiz ve yorumlama: B.B., A.Y.; Makalenin hazırlanması: B.B., A.Y.; Veri düzenleme, yöntem geliştirme, yazım – özgün taslak, yazım – gözden geçirme ve düzenleme: B.B., A.Y.; Tüm yazarlar, makalenin temel noktalarını eleştirel bir bakış açısıyla değerlendirmiş ve son halini onaylamıştır.

Design and planning of the study: A.Y., B.B.; Data collection, analysis, and interpretation: B.B., A.Y.; Manuscript preparation: B.B., A.Y.; Data organization, methodology development, writing – original draft, writing – review and editing: B.B., A.Y.; All authors critically reviewed the key points of the manuscript and approved the final version.

Teşekkür / Acknowledgements

Note: Bu çalışma Dr. Öğretim Üyesi Barış Baydemir danışmanlığında 2023 tarihinde tamamladığımız "Basketbolcularda Isınma Periyodunda Uygulanan Farklı PAPE Protokollerinin Performansa Etkisi" başlıklı yüksek lisans tezi esas alınarak hazırlanmıştır (Yüksek Lisans Tezi, Çanakkale Onsekiz Mart Üniversitesi, Çanakkale, Türkiye, 2023).

This article is extracted from my master thesis dissertation entitled "The Effect Of Different PAPE Protocols In The Warm-up Period Of Basketball Players On Performance", supervised by Asst. Prof. Barış Baydemir (Master's Thesis, Çanakkale Onsekiz Mart University, Çanakkale, Turkey, 2023).

APA Citation
Yalçın, A., & Baydemir, B. (2025). The Effect of Different PAPE Protocols in the Warm-Up Period of Basketball Players on Performance. *International Journal of Health, Exercise, and Sport Sciences (IJOSS)*, 2(1), 77-87.

MLA Citation
Yalçın, Ahmet, and Barış Baydemir. "The Effect of Different PAPE Protocols in the Warm-Up Period of Basketball Players on Performance." *International Journal of Health, Exercise, and Sport Sciences (IJOSS)*, vol. 2, no. 1, 2025, pp. 77-87.

ISO 690 Citation
YALÇIN, Ahmet; BAYDEMIR, Barış. The Effect of Different PAPE Protocols in the Warm-Up Period of Basketball Players on Performance. *International Journal of Health, Exercise, and Sport Sciences (IJOSS)*, 2025, vol. 2, no. 1, p. 77-87.

Vancouver Citation
Yalçın A, Baydemir B. The Effect of Different PAPE Protocols in the Warm-Up Period of Basketball Players on Performance. *International Journal of Health, Exercise, and Sport Sciences (IJOSS)*. 2025;2(1):77-87.

References / Kaynaklar

Avloniti, A., Chatzinikolaou, A., Fatouros, I.G., Avloniti, C., Protopapa, M., Draganidis, D., Stampoulis, T., Leontsini, D., Mavropalias, G., Gounelas, G., & Kambas, A. L. (2016). The acute effects of static stretching on speed and agility performance depend on stretch duration and conditioning level. *Journal of Strength Cond Research*. 30(10).

Balsalobre-Fernández, C., Glaister, M., Lockey, R. A. (2015). The validity and reliability of an iPhone app for measuring vertical jump performance. *Journal of Sports Sciences*, 33(15).

Bautista, I. J., Martín-Rivera, F., Martínez, I., Haff, G. G., & Maroto-Izquierdo, S. (2022). The influence of calculation method and relative strength on the load-velocity relationship in bench press exercise. International Journal of Sports Science & Coaching, 17(3), 576-582.

Baydemir, B., & Alp, M. (2018). The Effects of Specific Trainings Applied to 14 Age Male Soccer Players on Their Balance, Sprint and Technical Skills. *Journal of Education and Training Studies*, *6*(11), 27-31.

Benazeera, U. J. (2014). Association between eating habits and body mass index (BMI) of adolescents. Int J Med Sci Public Health, 3(8), 940-3. ISO 690.

Berriel, G. P., Cardoso, A. S., Costa, R. R., Rosa, R. G., Oliveira, H. B., Kruel, L. F. M., & Peyré-Tartaruga, L. A. (2022). Effects of Postactivation Performance Enhancement on The Vertical Jump in High-Level Volleyball Athletes. *Journal of human kinetics*, 82, 145–153.

Blazevich, A. J., Babault, N. (2019). Post-activation Potentiation Versus Post-activation Performance Enhancement in Humans: Historical Perspective, Underlying Mechanisms, and Current Issues. Frontiers in physiology, 10.

Brzycki, M. (1993). Strength testing—predicting a one-rep max from reps-to-fatigue. *Journal of Physical Education, Recreation & Dance*, 64(1), 88-90.

Chen, Z. R., Wang, Y. H., Peng, H. T., Yu, C. F., & Wang, M. H. (2013). The acute effect of drop jump protocols with different volumes and recovery time on countermovement jump performance. *The Journal of Strength & Conditioning Research*, 27(1), 154-158.

Dello Iacono, A., Padulo, J., Eliakim, A., Gottlieb, R., Bareli, R., Meckel, Y. (2016). Post-activation potentiation effects on vertical and horizontal explosive performances of young handball and basketball athletes. *The Journal of sports medicine and physical fitness*, 56(12), 1455–1464.

Docherty D, Hodgson MJ. (2007). The application of postactivation potentiation to elite sport. Int J Sports Physiol Perform. 2(4):439-44.

Draper, J., Lancaster, M. (1985). The 505 test: A test for agility in the horizontal plane performance. Exerc Sport Sci Rev, 31, 8-12.

Eken, Ö., Mainer-Pardos, E., Yagin, F. H., Eken, I., Prieto-González, P., & Nobari, H. (2022). Motoric performance variation from morning to evening: 80% intensity post-activation potentiation protocol impacts performance and its diurnal amplitude in basketball players. Frontiers in psychology, 13, 1066026.

Fradkin, A., Zazryn, T. ve Smoliga, J. (2010). Effects of warming-up on physical performance: a systematic review with meta-analysis. *Journal of Strength and Conditioning Research* 24(1), 140-148.

Gabbett, T., Sheppard, J. M., Pritchard-Peschek, K. R., Leverit, M. D. ve Aldred M. J. (2008). Influence of closed skill and open skill warm-ups on the performance of speed, change of direction speed, vertical jump, and reactive agility in team sport athletes. *Journal of Strength and Conditioning Research*, 22(5).

Gepfert, M., Golas, A., Zajac, T., & Krzysztofik, M. (2020). The Use of Different Modes of Post-Activation Potentiation (PAP) for Enhancing Speed of the Slide-Step in Basketball Players. *International journal of environmental research and public health*, 17(14), 5057.

Hodgson M, Docherty D, Robbins D. (2005). Post-activation potentiation: underlying physiology and implications for motor performance. Sports Med. 35(7):585-95.

Holt, B. W., Lambourne K. (2008). The impact of different warm-up protocols on vertical jump performance in male collegiate athletes. *Journal of Strength and Condition Research*. 22(5), 1720. doi: 10.1519/JSC.0b013e31815f9d6a.

Kilduff, L. P., Bevan, H. R., Kingsley, M. I., Owen, N. J., Bennett, M. A., Bunce, P. J. ve Cunningham, D. J. (2007). Postactivation potentiation in professional rugby players: Optimal recovery. *Journal of Strength and Conditioning Research*, 21(4), 1134.

Lockie RG, Lazar A, Davis DL, Moreno MR. Effects of Postactivation Potentiation on Linear and Change-of-Direction Speed. *Strength and Conditioning Journal.* 2018;40(1):75-91.

Markovic, G., Dizdar, D., Jukic, I., e Cardinale, M. (2004). Reliability and factorial validity of squat and countermovement jump tests. *The Journal of Strength & Conditioning Research,* 18(3), 551-555.

Marshall J, Turner AN, Jarvis PT, Maloney SJ, Cree JA, Bishop CJ. (2019). Postactivation Potentiation and Change of Direction Speed in Elite Academy Rugby Players. J Strength Cond Res. 33(6):1551-6.

McLaren, T., King, D. L., Sforzo, G. A. (2017). Sustainability and repeatability of postactivation potentiation. *Journal of Sports, Medicine and Physical Fitness.* 57.

Needham, R., Morse, C., Degens, H. (2009). The acute effect of different warm-up protocols on anaerobic performance in elite youth soccer players. *Journal of Strength and Conditioning Research,* 23(9), 2614-2620. doi: 10.1519/JSC.0b013e3181b1f3ef.

Padulo, J., Eliakim, A., Gottlieb, R., Bareli, R. ve Meckel, Y. (2015). Post-activation potentiation effects on vertical and horizontal explosive performances of young handball and basketball athletes. *The Journal of Sports Medicine and Physical Fitness,* 56(12), 1455-1464.

Rassier DE, Macintosh BR. (2000). Coexistence of potentiation and fatigue in skeletal muscle. Braz J Med Biol Res. 33(5):499-508.

Robbins, D. W. ve Docherty, D. (2005). Effect of loading on enhancement of power performance over three consecutive trials. J Strength Cond Res. 19, 898–902.

Sale DG. (2002). Postactivation potentiation: role in human performance. Exerc Sport Sci Rev. 30(3):138-43.

Silva, L. M., Neiva, H. P., Marques, M. C., Izquierdo, M. ve Marinho, D. A. (2018). Effects of warm up, post warm up, and re warm up strategies on explosive eforts in team sports: A systematic review. Sports Med, 48(10), 2285-2299.

Stewart, P. F., Turner, A. N. ve Miller, S. C. (2014). Reliability, factorial validity, and interrelationships of five commonly used change of direction speed tests. *Scandinavian Journal of Medicine & Science in Sports,* 24(3), 500–506.

Sygulla, K. S. ve Fountaine, C. J. (2014). Acute post-activation potentiation effects in NCAA division II female athletes. *International Journal of Exercise Science*, 7(3), 212.

Tillin, N. A., & Bishop, D. (2009). Factors modulating post-activation potentiation and its effect on performance of subsequent explosive activities. Sports medicine (Auckland, N.Z.), 39(2), 147–166.

Tseng, K. W., Chen, J. R., Chow, J. J., Tseng, W. C., Condello, G., Tai, H. L., & Fu, S. K. (2021). Post-activation Performance Enhancement after a Bout of Accentuated Eccentric Loading in Collegiate Male Volleyball Players. *International journal of environmental research and public health,* 18(24), 13110.

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.

Xie, H., Zhang, W., Chen, X., He, J., Lu, J., Gao, Y., Li, D., Li, G., Ji, H., Sun, J. (2022). Flywheel eccentric overload exercises versus barbell half squats for basketball players: Which is better for induction of post-activation performance enhancement?. PloS one, 17(11), e0277432.

Zagatto, A. M., Claus, G. M., Dutra, Y. M., de Poli, R. A., Lopes, V. H. F., Goodall, S., Loturco, I., & Boullosa, D. (2022). Drop jumps versus sled towing and their effects on repeated sprint ability in young basketball players. BMC sports science, medicine & rehabilitation, 14(1), 4.

Publishers' Note