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The effect of post activation potentiation (PAP) warm-up on repeated sprint ability on youth basketball players

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Abstract:

This study is aimed to know the effect produced by the post activation potentiation warm-up on repeated sprint ability on youth basketball players, where the experimental method was used in a one group design and applied to 15 players from the basketball youth club (JBS) that belongs to the Annaba state association, the protocol was implemented which starts with normal warm-ups, then doing the RSA test and taking a full rest, then perform the PAP warm-up by using the 5RM in ½ squat with a rest of 04 minutes between warm-up and carrying out the test again, the results were as follows:

The post activation potentiation warm-up improves the performance of repeated sprint ability on youth basketball players, Where we get an improvement rate (6.36%) in max sprint time, and (5.47%) in average sprint time.

Keywords: post activation potentiation; repeated sprint ability; warm-up.

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1. INTRODUCTION

The basketball player, as all the players, is characterized by double-positioning in play from defense to attack and from attack to defense, and this is evident by continuous movements and at different speeds, short, medium and high, and this movement is sudden changes in direction, which leads sideways forward to the back and is followed by stopping or increasing speed, from a technical and tactical point of view, competition is specialized and is characterized by elevation of shooting from different positions (from stability or high jump) from close, from distance or after dribbling with the ball, and all this is performed in a systematic and appropriate manner by choosing the appropriate time and type of movement as well as the place of its performance.

Sprint and high-intensity intermittent efforts are very common activities in team and racket sports such as handball, basketball, soccer, and tennis, these sports are characterized by multiple short sprints, accelerations, and decelerations with changes of direction, which are collectively called repeated-sprint ability (RSA). (Spencer, 2005, p. 1028)

The warm-up is widely understood as a preparation practice to perform before any physical exercise. It is usually used by athletes, coaches, and general physical activity participants, to obtain an optimal physical and psychological state and to get kinetic and coordinative preparation in the prevention of injuries during the practice. (Fradkin AJ, 2010, p. 143)

It is then important to understand the effect of warm-up in strength performance and this may be through the assessment of maximum dynamic strength (load at 1 repetition maximum: 1RM), isometric strength, or even through the rate of production of muscle strength. (Neiva HP, 2019, p. 74)

Previous findings suggested that the warm-up procedure (for example, aerobic exercise, specific activity, and stretching) seems to influence the results of the 1RM assessment, as well as to improve the strength produced during the assessments. (McGowan CJ, 2015, p. 1526)

We all know that the general warm-up is usually completed using an aerobic activity of low to moderate intensity with the main purpose to increase the muscle temperature, which can be performed with different types of aerobic activity (for example, running or cycling). Stretching exercises can also be performed as part of a typical warm-up routine. Regarding the specific warm-up, it is recommended to perform it by including exercises that use the same or similar movements as the

main activity at progressively higher intensities in an attempt to increase neuromuscular activation. (Bishop D, 2003, p. 487)

The post activation potentiation warm-up effect depends on the balance between fatigue and neuromuscular potentiation, which in turn depends on the type of exercise, volume, intensity, and recovery time. (Tillin NA, 2009, p. 150)

However, the PAP effect may be observed after the application of maximal loaded, submaximal loaded and unloaded exercises, especially when performed with the intention of maximizing movement velocity, leading to the recruitment of fast-twitch muscle fiber, which is considered a key factor to induce PAP. (Turner AP, 2015, p. 345)

After all of the above, we can say that improving performance in basketball still needs more recent studies and experimentation with new methods so that it does not need a lot of time and effort to achieve better results

According to the aforementioned, this research imposes the following general question:

- Does post activation potentiation warm-up improve the performance of repeated sprint ability on youth basketball players?

1.1 sub- questions:

- Does post activation potentiation warm-up improves max sprint time on youth basketball players?
- Does post activation potentiation warm-up improves average sprint time on youth basketball players?

1.2 Research Hypotheses:

1.2.1 General Hypothesis:

- Post activation potentiation warm-up improves the performance of repeated sprint ability on youth basketball players.

1.2.2 sub- Hypotheses:

- Post activation potentiation warm-up improves max sprint time on youth basketball players.
- Post activation potentiation warm-up improves average sprint time on youth basketball players.

1.3 Research Objectives:

The present research has the following objectives:

-To identify the Effect of post activation potentiation warm-up on repeated sprint ability on youth basketball players.

-To compare between the normal warm-up and the warm-up that depends on



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post activation potentiation, and which one improves the repeated sprint ability on youth basketball players.

-To see if we can rely on the heating method of the post activation potentiation warm-up to improve speed on sprint and the ability to keep it up for a long time.

-To find out the percentage of improvement in the repeated sprint ability on youth basketball players and generalize the results.

1.4 Previous Studies:

1.4.1 The first Study:

Doctoral thesis in exercise and human movement sciences (Australia), carried out by Zoiss. J (2011) entitled: "Optimization of warm-up protocols in Football". Its main objectives are summarized as follows:

- Bibliographic analysis on warming up and potentiation
- study the optimization of high intensity and short duration pre-competition warm-up protocols (5 RM and reduced games) in football.
- study the effects of short-duration, high-intensity warm-up protocols (which aimed to produce a PAP effect), on short-duration performance, on intermittent work and during warm-up during the break of the half-time compared to the standard warm-up.

The researcher used the experimental and cross-sectional method, where the sample was composed of ten amateur players from the Italian D series aged between 21 and 25 years old. The results of this study showed improved performance in CMJ (2 – 6%), Agility Test (4–5%) and (RSA) Repeated Sprint Ability (~10%) during warm-up protocols high intensity and short duration (5 RM and the one based on reduced games). The researcher recommends using the pre-competition PAP-inducing (5RM) warm-up better than the standard warm-up, as it has a positive effect on short-term and long-term performance for team sports during intermittent activities.

Another highlight is to avoid the use of a long warm-up (>15 min) on explosive activities, as they have a negative effect on performance. In addition, a brief warm-up during the break between halves in high-intensity, team sports that combines explosive drills and skill repetition (~3 min) would be a recommended method for physical preparation of athletes.

1.4.2 The second Study:

A doctoral thesis in exercise science and human movement (USA), carried

out by Smith. C.E (2012) titled: “The Effects of Post-Activation Potentiation Warm-Up on Post-Sprint Performance”.

The objectives of this study were to examine the influence of a PAP-inducing warm-up protocol (with loads) on subsequent sprint performance in well-trained athletes of both sexes.

It also aimed to determine the effects of the resistance of the sled of different loads used during the warm-up protocol (0%, 10%, 20% and 30% of the individual's weight), on sprint performance over 40 yards (36.57 m) without load.

Another objective and not the least, is the determination of the type of muscle fiber (type II) composing the musculature of the study sample.

The researcher used the experimental and cross-sectional method.

The sample consisted of twenty four athletes of both sexes aged between 18-28 years. The results of this study showed improved main effect performance in the pre- and post-40 yards regardless of gender. Athletes improved 40-yard time by an average of 1.2% after using the load of 10% of the athlete's body weight; while for the sprint without resistance (0% load), and with 20% and 30% loads, the improvements were more than 2% on average.

The results of this study suggest that athletes may benefit from using heavier sled loads as part of the PAP in the warm-up to improve sprint performance. Lighter sled loads are undesirable and may provide less significant improvement for athletes if used during pre-competition warm-up.

2. Research Terms and Concepts:

2.1 post activation potentiation (PAP):

PAP is defined as an enhanced neuromuscular state observed after the execution of a high intensity exercise.

This phenomenon describes the immediate enhanced muscular strength output of explosive movements after performing an intense resistance exercise, i.e. a high preload leads to a high degree of CNS stimulation resulting in increased motor unit recruitment and strength, which can last from 05 to 30 minutes. (Robbins, 2005, p. 455)

The derivation of the PAP definition reflects the observation that an increase in muscle twitch contraction force follows a maximal or near maximal voluntary contraction. The increased muscle twitch force is thought to be due to an increase in myosin light chain phosphorylation making actin-myosin more sensitive to Ca^{2+} during subsequent contractions, Adaptations of reflex activity in the spinal cord, following execution of a high intensity exercise, are also hypothesized to



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contribute to the PAP response, In the whole human as opposed to an isolated muscle twitch, PAP does not increase muscle maximal force production, however, PAP does increase the rate of force development. (Xenofondos, 2010, p. 34)

2.2 repeated sprint ability (RSA):

It is the player's ability to repeat runs at high speeds up to maximum intensity several times without significant loss of performance, with a rest period between each run.

This test is one of the most important tests used to determine the athlete's ability to repeat the speed for a long time. (Qurumi Al-Hussein, 2021, p. 687)

The test RSA is a test consisting of 07 quick, consecutive runs of 34.2 meters (30 meters with a lateral change between 20 and 30 meters) with 25 seconds of positive rest between each runs.

This test enables us to measure the following characteristics:

- The best time to run out of the 7 runs.
- Average time for all sprints.
- The difference between the best and worst time, which is an indicator of fatigue. (Bangsbo, 1994)

2.3 warm-up:

It is all the procedures that precede the competition or the training session that will make the athlete reach the optimum state of physical, psychological and even kinetic preparation, which at the same time plays an important role in the prevention of sports injuries. (WEINCK, 2003, p. 477)

The warm-up is the transitional period from the state of rest to the state of exertion, which allows the athlete to gradually enter into the atmosphere of competition or training and prepare him from all physical, psychological and kinetic aspects, and to prevent injuries (pasquet G, 2004, p. 135)

Warming up is a key concept in physical activity and sport. The interest of warming up is well established.

According to Dr. Panel: "Warming up is a prelude to any training, to any competition. It is a moment that allows the athlete to derive the maximum benefit from his action, while saving his vital potential", it is also "all the measures allowing to obtain an optimal state of psychological and motor (kinesthetic) preparation.

Before training or competition, and which at the same time play an important role in injury prevention" (WEINCK, 2003, p. 478)

3. The Methodology of the study:

3.1 The Exploratory study:

The exploratory study was the first step to launch at the beginning of this study and its steps were as follows:

- Gathering scientific and theoretical information and examining studies related to the topic.
- Previewing the place of the study and controlling the community and the sample.
- Taking anthropometric measurements for all members of the study sample.
- Applying the 1 RM maximum strength test for the half squat for all members of the study sample.
- Application of the exploratory study on 03 randomly selected individuals and subsequently excluded from the original sample by following the normal warm up protocol and then applying the test and then taking a complete rest, after that warming up with pap and then re-testing in the time period 11/27/2021.
- Conducting honesty and reliability transactions through the results of the exploratory study tests.

3.2 Research Methodology:

The method is defined as a set of processes and steps that the researcher follows in order to achieve his research (Zerwati, 2007)

Also, the research methods differ in the research according to the research problem and its objectives, as well as according to the difference required to be searched for, so researchers can follow different scientific methods, and from this point of view and due to the nature of our subject of knowledge, we decided to rely on the experimental method by designing one group for its suitability to the nature of the current study.

3.3 Research population:

It includes all clubs and teams belonging to the Regional League of Annaba, which numbered 12 registered teams for the 2021/2022 sports season, and who are located in a geographical area close to the researcher.

3.4 Research sample:

Returning to the nature of the research and the methodology used in it, the research sample was chosen by the deliberate elective method, by selecting the Sedrata Youth Basketball Club (JBS), and then individuals with the same physical characteristics were selected in order to achieve homogeneity among them.



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In the end, 15 basketball players under 18 years of age with similar characteristics and specifications were collected.

3.4.1 Sample properties:

Table 1. The characteristics of the study sample

Measurements	N	Mean	Std. Deviation	Std. Error Men
Tall (m)	15	1.83	0.052	0.013
Wight (kg)		65.94	3.021	0.78
IMC (kg/m ²)		19.66	1.099	0.284
1RM (kg)		59.32	3.422	0.883

Source: author, 2022

3.5 Research Tool:

In order to reach solutions to the problem posed and to verify the validity of the study hypotheses, the most effective methods and tools must be followed through study and browsing. Therefore, the following data collection tools will be relied upon:

3.5.1 Theoretical studies (bibliographical analysis):

Books, articles, previous studies, Arabic and English references, magazines, the Internet, the aim of which is to create a theoretical background that helps to complete the study.

3.5.2 Designing the research tool:

3.5.2.1 Post activation potentiation Warm-up protocol:

After doing the initial warm-up and taking the results of the repeated sprint ability test and then taking a full rest, the pap warm-up was done by doing 5 repetitions of half-squats($\frac{1}{2}$ squat) using 80 % of 1RM which means (5RM), then taking 04 minute rest and then re-test the Repeated sprint ability test.

3.5.2.2 Repeated sprint ability protocol:

The Repeated sprint ability test consists of 7 consecutive runs of 30 meters separated by 25 seconds of rest, and in each run there is a change of direction while doing the speed, which makes the test difficult to continue to maintain the speed at its highest levels.

The best time between the seven times and the average times is scored for each player.

3.5.3 Measurements used:

- Measure the total length of the body.
- 1RM Half Squat Test.
- Measurement of weight, body mass index and fat percentage.
- RSA repeated sprint ability Test.

3.5.4 Equipment used for measuring:

- xiaowmi mi 2 lpn4008cn electronic medical scale and measures weight, sub-body ratio, fluid, bone and muscle mass ratio.
- Micro gate witty: wireless training timer for testing the speed.
- Rest meter for total length of the body.

3.5.5 Statistical means:

In order to reach the results of the study and answer the question of: “Does post activation potentiation warm-up improve the performance of repeated sprint ability on youth basketball players”, the researcher used the statistical treatments:

- SMA (mean).
- Standard deviation (std).
- percentages.
- Test of Normality (Kolmogorov-Smirnov)
- Student's T test.
- SPSS program.

3.6 Presentation and analysis the results:

3.6.1 Presentation and analysis the results of the first hypothesis tagged with:

"post activation potentiation warm-up improves max sprint time in youth basketball players."

In order to start statistical processing and verify the validity of the hypothesis, we must first know the type of test to follow.

Therefore, we verified the moderation of the normal distribution of the sample results (Test of Normality), and the results were as follows:

Table 2. Tests of Normality

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Indications	Kolmogorov-Smirnov		
	Statistic	df	Sig
Max sprint time before (PAP)	0.138	15	0.200
Max sprint time after (PAP)	0.122	15	0.200

Source: author, 2022

Table No (2) shows: The sig value (0.200) is greater than the significance level (0.05), and this means that the results are distributed normally according to the Kolmogorov-Smirnov test.

Table 3. The results obtained after statistical processing

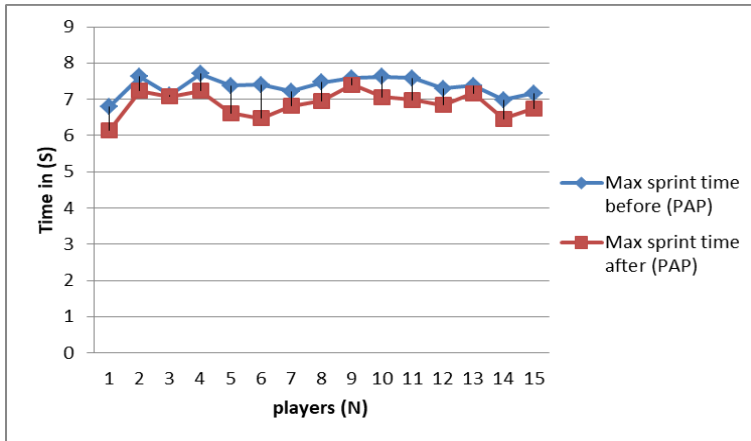
Indications	Statistical processing						Improvement rate
	N	Mean	Std. Deviation	T test	Df	Sig	
Max sprint time before (PAP)	15	7.35	0.261	8.102	14	0.00	6.36 %
Max sprint time after (PAP)		6.88	0.344			0.00	

Source: author, 2022

Table No (3) shows: That there are statistically significant differences between the test results before (PAP) warming up and after (PAP) warming up in max sprint time value.

Where the value of (T) calculated in the max sprint time value was (8.102), while the arithmetic mean was obtained in the pre-test (7.35) and the standard deviation (0.261), while in the post-test it achieved an arithmetic mean (6.88) and a standard deviation (0.344).

Fig.1. Curve graph of Max sprint time before and after (pap)



Source: author, 2022

Figure (1) shows: a graphical curve for the set of players' times values in the max sprint time before and after the (PAP) warm-up, where the preference appears in favor of the set of times after the (PAP) warm-up.

3.6.2 Presentation and analysis the results of the second hypothesis tagged with: "post activation potentiation warm-up improves average sprint time in youth basketball players."

In order to start statistical processing and verify the validity of the hypothesis, we must first know the type of test to follow.

Therefore, we verified the moderation of the normal distribution of the sample results (Test of Normality), and the results were as follows:

Table 4. Tests of Normality

Indications	Kolmogorov-Smirnov		
	Statistic	df	Sig
Average sprint time before (PAP)	0.179	15	0.200
Average sprint time after (PAP)	0.155	15	0.200

Source: author, 2022

Table No (4) shows: The sig value (0.200) is greater than the significance level (0.05), and this means that the results are distributed normally according to the Kolmogorov-Smirnov test.

Table 5. The results obtained after statistical processing

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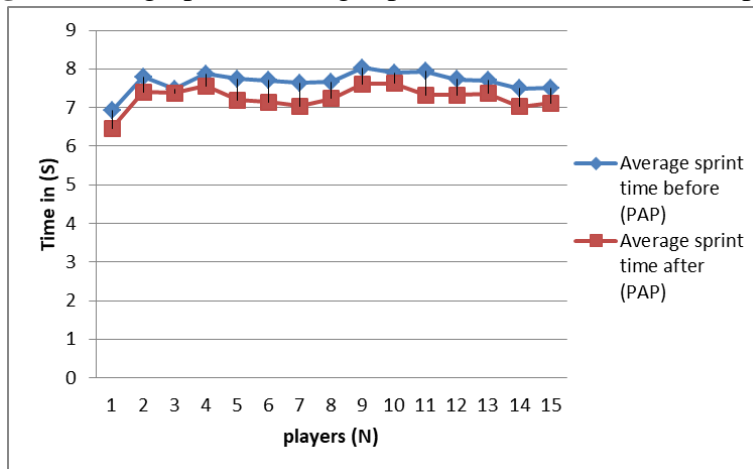
Indications	Statistical processing						Improvement rate
	N	Mean	Std. Deviation	T test	Df	Sig	
Average sprint time before (PAP)	15	7.67	0.264	12.234	14	0.00	5.47 %
Average sprint time after (PAP)		7.25	0.291			0.00	

Source: author, 2022

Table No (5) shows: That there are statistically significant differences between the test results before (PAP) warming up and after (PAP) warming up in average sprint time value.

Where the value of (T) calculated in the average sprint time value was (12.234), while the arithmetic mean was obtained in the pre-test (7.67) and the standard deviation (0.264), while in the post-test it achieved an arithmetic mean (7.25) and a standard deviation (0.291).

Fig.2. Curve graph of Average sprint time before and after (pap)



Source: author, 2022

Figure (2) shows: a graphical curve for the set of players' times values in the average sprint time before and after the (PAP) warm-up, where the preference appears in favor of the set of times after the (PAP) warm-up.

4. Discussion:

After calculating the percentage of improvement, we obtained a value (6.36 %) in max sprint time, which is a good percentage, and it can be compared with the results of the study of Zois. J (2011) which obtained similar results, The results of his study showed improved performance in (RSA) Repeated Sprint Ability (~10%) during warm-up protocols high intensity and short duration (5 RM on pap warm-up), also he recommends using the pre-competition PAP-inducing (5RM) warm-up better than the standard warm-up.

Studies that have examined the influence of PAP on a repeated ballistic movement activity such as sprinting, (Pfaff 1997) has reported that elite sprinters using protocol in which they performed 90% of their 1 repetition maximum (1RM) for 5 sets of 1 repetition of the back squat exercise with 2 minutes rest between sets and 20 minutes prior to competition, improved their sprinting performance.

Post activation potentiation (PAP) warm-up is governed by a multitude of physiological and biochemical mechanisms, the best known being the phosphorylation of myosin light chains.

Indeed, these chains are used during the preparation contraction, which increases the sensitivity of actin-myosin to Ca^{2+} released by the sarcoplasmic reticulum.

This modification could then lead to a shift of the force-velocity curve to the right, allowing faster movements with higher loads. (Loubna, 2021, p. 408)

This means that there are statistically significant differences in favor of the test results after post activation potentiation warm-up in max sprint time.

Since the value of Sig is less than the significance level of (0.05), we say that there are statistically significant differences between the pre-test and the post-test in favor of the post-test, and this means that the hypothesis that says "post activation potentiation warm-up improves max sprint time in youth basketball players." is correct.

Also After calculating the percentage of improvement, we obtained a value (5.47 %) in average sprint time, which is a good percentage, and it can be compared with the results of the study of (Zois. J 2011) which obtained similar results, The results of his study showed improved performance in (RSA) Repeated Sprint Ability (~10%) during warm-up protocols high intensity and short duration (5 RM on pap warm-up), also he recommends using the pre-competition PAP-inducing (5RM) warm-up better than the standard warm-up, Studies had already



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looked at the different warm-up methods and their influence on performance (Vendoze 2013) and (Robin Chaverot 2018). The results indicated that potentiating warm-up allowed better balance maintenance as time went on. Efforts and a level of performance maintained.

In a previous study by (Linder et al. 2010), which consists of a 4-minute standard warm-up, followed by a 4-minute active rest, 100-meter sprint, a second active 4-minute rest, a 4RM warm-up, parallel semi-back-squat, which is a third active 9-minute rest, ending with another sprint 100 meters. The results indicated that there was a significant improvement of 0.19 s, when the second sprint preceded the 4RM back squat pap warm-up protocol. (Xenofondos, 2010, p. 35)

That means there are statistically significant differences in favor of the test results after post activation potentiation warm-up in average sprint time.

Since the value of Sig is less than the significance level of (0.05), we say that there are statistically significant differences between the pre-test and the post-test in favor of the post-test, and this means that the hypothesis that says " post activation potentiation warm-up improves average sprint time in youth basketball players." is correct.

5. CONCLUSION

After discussing and analyzing the results of the study, and after verifying the hypotheses and their validity for the interpretation of the results obtained after statistical treatment, we can summarize the conclusion according to the following elements:

- The post activation potentiation warm-up improves max sprint time on youth basketball players.
- The post activation potentiation warm-up improves average sprint time on youth basketball players.
- The post activation potentiation warm-up improves the performance of repeated sprint ability on youth basketball players.
- We can say that the post activation potentiation warm-up contributes positively to raising the level of performance of the players, especially in the abilities that need speed and strength at the same time, and which need to recruit the largest possible number of muscle fibers to work together, which is achieved using the method of post activation potentiation warm-up. Which we can rely on to achieve better results.

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