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The effect of post-activation potentiation in the sprint in freestyle

O efeito da potencialização pós ativação no sprint em nado livre

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ABSTRACT
Post-Activation Potentialization (PPA) is defined as an acute improvement in muscle function after stimulation. Different variables of PPA protocols can affect performance, such as the duration, the type of stimulus, the level of training of the requirements and the time interval between the conditioning activity and the specific activity. In the Swimming sport, there is a recurring debate between the types of warm-ups that could benefit practitioners the most. From this, the interest in understanding the relationship between pre-sprint activity and performance in it arose. The objective of the present study was to identify the effect of PPA performed in aquatic or terrestrial environments, on the performance of the sprint performed in freestyle. The sample consisted of 19 individuals of both sexes, who have been swimming for at least one year. Professionals in the area of Physical Education consented to the tests that were applied in the research, they took place based on three protocols entitled "Control", "aquatic PPA" and "terrestrial PPA", on different days, with an interval between them and the entry was alternating. The researchers analyzed the data and, when comparing the three protocols, it was observed that 68% of the sample had the best sprint time in the control protocol, without the post-activation potentiations. Only six participants improved the time compared to the control, but it is an indication that the PPA is capable of enhancing performance depending on the methodology applied. When analyzing only the two PPA protocols, it was found that 12 of the 19 participants had the best sprint time after aquatic PPA, and only seven people after the terrestrial PPA protocol. Thus, it was possible to understand that the aquatic PPA had more satisfactory results in relation to the other potentiation protocol and this conclusion occurred regardless of gender.

Keywords: Post-activation potentiation, sprint and freestyle.

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1 INTRODUCTION

Post Activation Potentiation (PPA) is defined as an acute enhancement of muscle function after stimulation (HODGSON *et al.,* 2005). In addition, there is evidence that PPA can increase muscle strength and power following short, high-intensity stimuli (SALE, 2002). Performance after PPA has been studied in various sports such as resistance training, basketball, athletics, rugby and swimming (WEBER *et al*., 2008; GOLAS et *al.,* 2016, HAMADA et *al.,* 2000; Sarramian et al., 2015; KILDUFF et *al.* 2008; BARBOSA et al*.,* 2020 respectively).

Many studies have attempted to identify the physiological mechanisms that influence PPA performance in athletes, such as the type of bioenergetic source used during high-intensity stimuli (GAITANOS *et al.,* 1993); the type of muscle fiber recruited (HAMADA *et al*., 2000); the pitch angle of the muscle fibers and resistance to fatigue (CHIU *et al*. 2003; RASSIER & MACINTOSH, 2000; SALE, 2002).

However, the lack of studies on specific stimuli for PPA in swimming is still a reality (BARBOSA, *et al*., 2015). Therefore, in this work, the application of PPA was researched in the context of this sport and based on three protocols stipulated by the authors themselves.

Regarding swimming, the free swim is when the athlete can reach the highest speed in the water (ABBES *et al*., 2018). In competitive competitions the so-called *sprints* are performed, which are power activities and considered predominantly anaerobic due to the short duration time. (GAITANOS *et al*., 1993).

As for the mode of warm-up in swimming, Neiva *et al*. (2014) sought, through various protocols in water, to evaluate the importance of warm-up in this sport. Moreover, other studies that tried to find an ideal protocol for swimming, using PPA, did not reach any consensus. For this activity there are different variables that can affect performance, among them, the duration of the stimulus (ABBES, 2018), type of stimulus (ABBES, 2018; SARRAMIAN, 2015), the level of training of individuals (CHIU *et al.* 2003; HAMADA, 2000) interval time between the conditioning activity and the specific activity (KILDUFF *et al.* 2011; RASSIER & MACINTOSH, 2000).

There are some gaps in the current literature, since there is no consensus about the use of PPA protocol for warm-up in swimming, as well as the best way to apply it to enhance performance. Therefore, the relevance of this study is due to the possibility of replicating the established procedure and using it in training research for high performance athletes, aiming at a better performance through different protocols involving PPA.

Considering the researches done previously and mentioned above, in search of the ideal protocol for the use of PPA with swimming, the general objective of this study was to compare different protocols of PPA and its relation with the 25 meters *sprint* in free swimming. To fulfill the general objective, the specific objective was to analyze the PPA performed on land and water after standard warm up, relating it to the 25 meters *sprint* time in free swimming, trying to find the most appropriate protocol for the athletes' performance.

The true hypothesis of this study indicated that there would be no difference between the results of the protocols. The alternative hypothesis was that the PPA that occurred in the aquatic environment resulted in more benefit and potency in the *sprint* compared to the terrestrial PPA, since the former potentiates more closely to the specific motor gesture of swimming.

2 METHODOLOGY

The present study was carried out based on theoretical-empirical content in which the researchers analyzed the existing literature on the subject, in addition to the possibility of going into the field in search of new data for the research. It is also possible to consider it a clinical trial since tests and protocols were used as methods. Thus, the objective was to verify the effect of post-activation potentiation on *sprinting in* free swimming through relevant articles and practical tests.

The sample was composed of 19 individuals, 12 men and seven women, aged between 18 and 40 years old, all of whom are students at gyms in Rio de Janeiro.

The sample questionnaires were answered by the participants with questions about gender, age group, which and for how long they had practiced physical or leisure activities, as well as information about: swimming habits, use of swimming accessories, squatting, and push-ups. These answers helped organize the inclusion criteria. The individuals should have been practicing non-competitive swimming for at least one year, and the standard warm-up performed in the tests was also based on the answers found in the questionnaires.

Table 1 - Characterization of the sample

Name	Age group (years)	Practice time (years)
1	Between 30 and 40	Above 4
2		
3		Up to 2
4		Above 4
5		From 2 to 4
6		Above 4
7		
8		
9		
10		
11		
12		
13		
14	Between 20 and 30	Up to 2
15	Between 30 and 40	Above 4
16	Less than 20	Up to 2
17	Between 30 and 40	Above 4
18		
19		

In the first step of the methodology, the anamnesis occurred in which all participants filled out the questionnaire to verify the sample profile, as well as the physical activity readiness questionnaire (PAR-Q) and the signing of the informed consent form (ICF). The procedures and objectives of the work were also explained, thus releasing the initiation of the study.

In the second stage, the researchers started applying the tests. The collection occurred in two sessions, with a one-week interval between them. The protocols were numbered for better understanding of the methodology, however, each participant performed them following an order defined by lot and indicated in the flowchart.

The first protocol was the "Control", in which the entire sample performed the standard warm-up established according to the questionnaire answers, which lasted ten minutes in free swimming. After the eight-minute interval, everyone did a 25-meter *sprint in free swimming,* and the time was recorded and entered into the test worksheet.

The second protocol consisted of the same standard warm-up described earlier (ten minutes of free swimming) and, after an eight-minute interval, the PPA session was initiated. In this case, the PPA was in the aquatic environment with two *sprints of* 12.5 meters, with the aid of palmar and fin (duck foot), there was an interval of one minute between each one and all participants used the equipment mentioned. After eight minutes the 25 meters *sprint* occurred in free swimming, the times were recorded and noted.

The third protocol started with the same standard warm-up of ten free minutes in the pool and, after an eight-minute break, the PPA session started. In this case, the PPA was in a terrestrial environment, with execution of ballistic exercises, being ten maximal jumps with the hands at the waist and five arm push-ups on the ground. Soon afterwards, the individuals swam a distance of 12.5 meters, free swimming. The participants performed two sets, with a one-minute rest between each set. After the series, there was an eight-minute break and, after resting, a 25-meter *sprint in free swimming*.

The protocols followed the same standards, participants wore the same outfits during all tests. The exit from the outside of the pool, from the dive, was not used since it could interfere with the timing of the *sprints*. Therefore, each individual held the edge of the pool with one hand and positioned the other hand in front, and with both feet fixed on the edge to start the test.

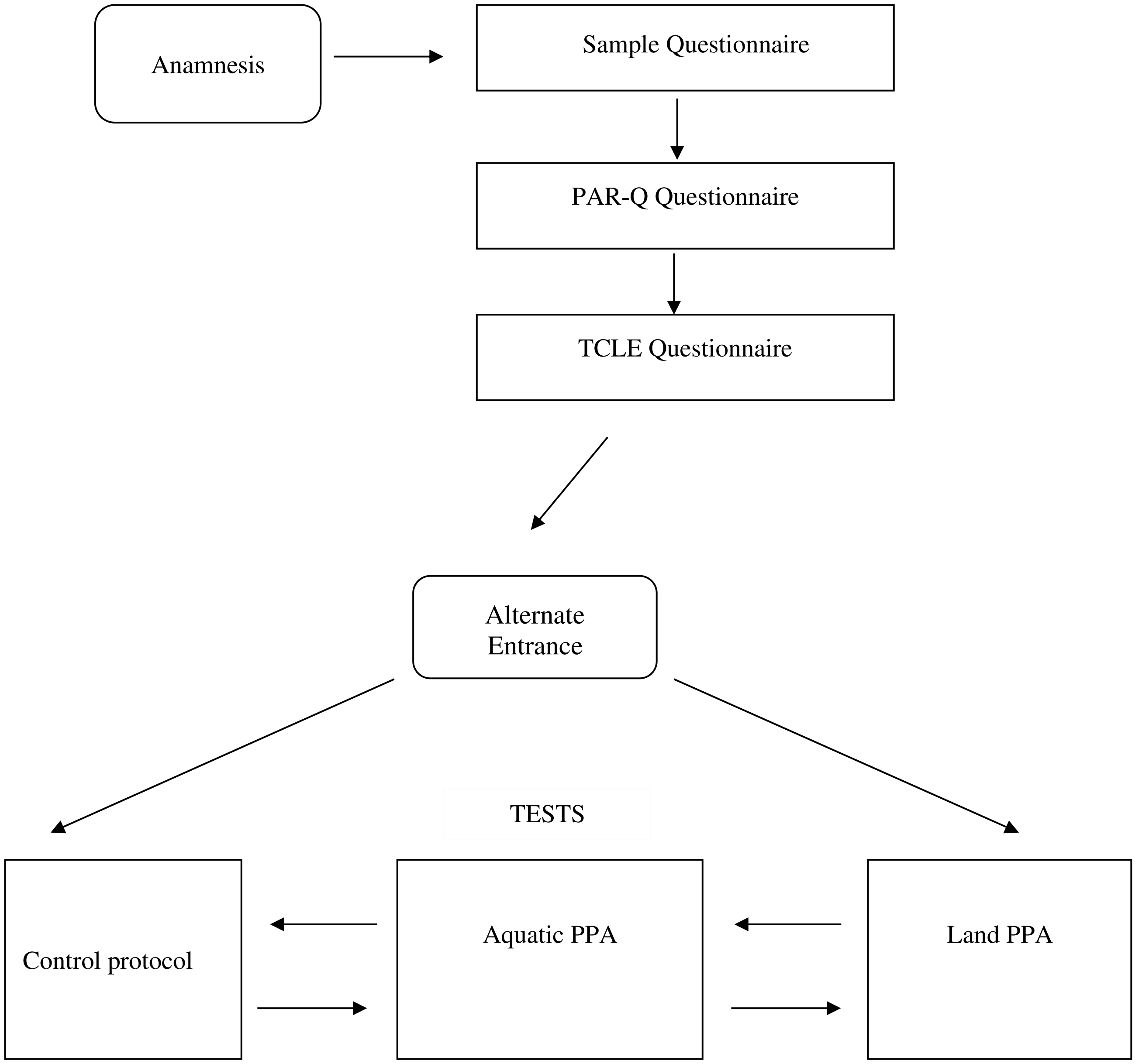
The researchers used a digital stopwatch to count the time, and the start of the test was given by the evaluator through a sound signal (whistle). After performing the three protocols, the data were analyzed and plotted for statistical treatment to occur, as shown in the results and data discussion section.

The method of the present study included the three protocols described above, however, they did not necessarily take place in this order, since the participants' entry into the research was alternated and decided by a draw by the evaluators.

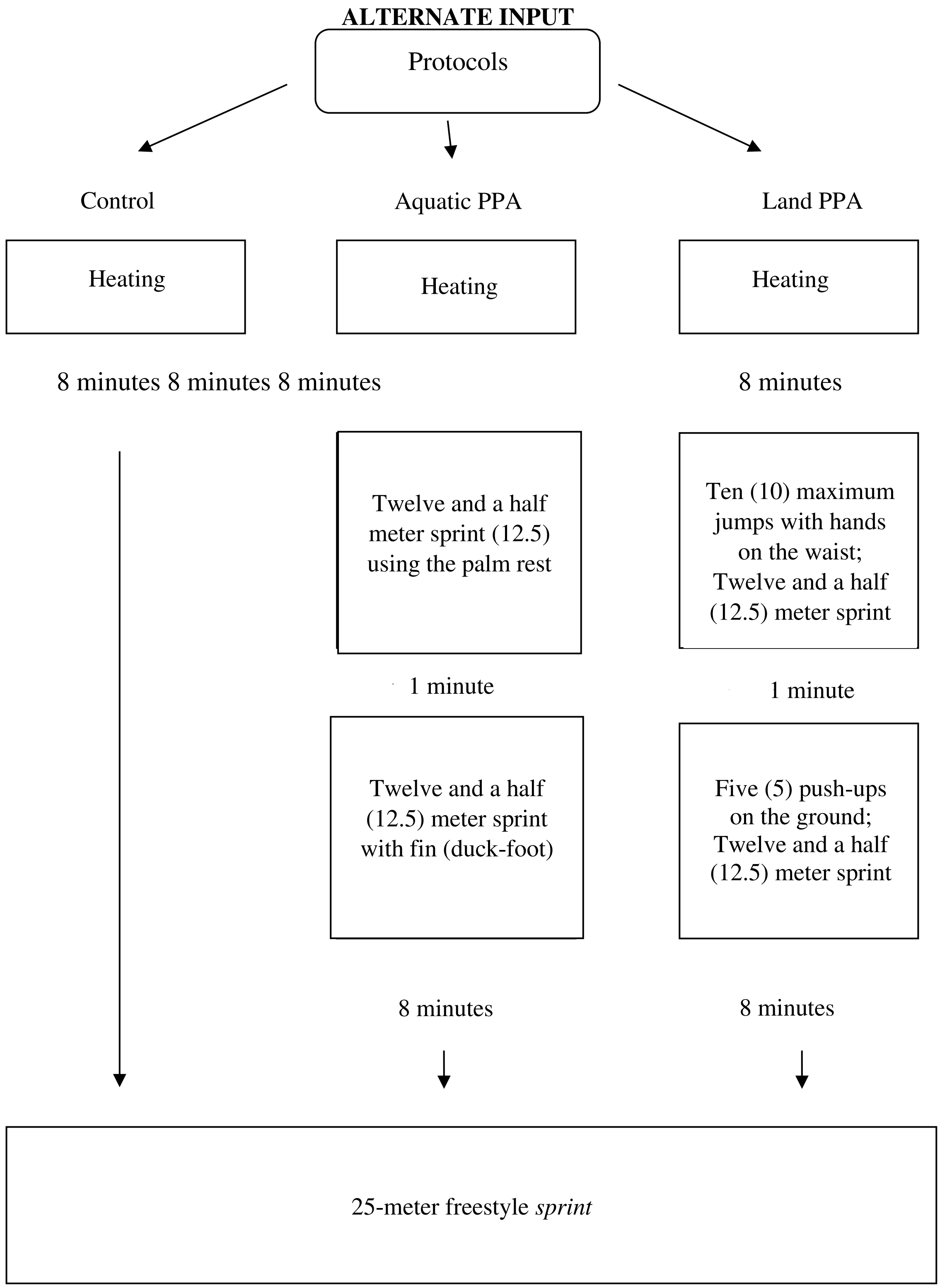
It is important to emphasize that the resting time is of utmost importance, since during this interval between the conditioning activity and the execution of the test, the individual is exposed to the so-called "window of opportunity" in which there is potentiation and fatigue. The stipulated time must be enough for the potentiation to overcome the fatigue condition for the PPA to be effective (HODGSON *et al.,* 2005).

The interval used in Abbes' (2018) study was based on similar work by author Kilduff *et al.* (2011) who evaluated the effects of PPA in *sprints* with swimming athletes and the goal was to investigate the optimal recovery time. All swimmers had a peak power output after eight minutes of rest between the conditioning activity and the specific activity. Thus, based on the results of this research, the time adopted for the present study was eight minutes between the conditioning activity and the *sprint*, aiming to use the peak of PPA.

Vertical Flowchart 1 - Organization and steps for analysis of the effect of PPA in the 25-meter sprint in free swimming



Vertical Flowchart 2 - Details of the protocols, intervals and PPA executed in the 25-meter sprint tests in free swimming



3 RESULTS

It was observed that there was a difference in the time between the three protocols performed with the sample, among them the "Control" protocol proved to be more effective since 13 people had the shortest time, without the use of any type of PPA. This number represents 68% of the total sample, which is a very expressive quantity and requires further studies to deepen these results. The other 21% were from the terrestrial PPA and the remaining 11% corresponded to the aquatic PPA, among the three protocols, thus, the most indicated would be the "Control".

However, analyzing only the two protocols of aquatic and land-based PPA, it was found that 12 of the 19 participants achieved the best time in the *sprint* performed after the aquatic PPA, and only seven people achieved a better performance in the *sprint* after the land-based PPA protocol, in general it is possible to understand that the first PPA (aquatic) had a more satisfactory result.

It is important to emphasize that the sample used is mixed, composed of 12 men and 7 women. Thus, among the 12 participants who had the shortest time after the aquatic PPA, four were women. And in the land-based PPA, of the seven people who had a shorter *sprint* time, three were women. When analyzing the data focusing specifically on the female audience, it can be said that the best performance occurred in the aquatic PPA.

In relation to the male audience, the result also coincided, eight men had the shortest time after the aquatic PPA, in opposition to the four men who were better after the terrestrial PPA. It is possible to conclude that, although the study sample was mixed, the result prevailed regardless of gender finding that the shortest *sprint* time occurred after the protocol used in aquatic PPA.

Although the improvement in time occurred only with six participants, in relation to the *sprint* performed in the "Control" protocol, it is an indication that the PPA is able to enhance the performance depending on the methodology that is applied. It is recommended that further studies be carried out in order to reach a consensus and improve the warm ups performed in aquatic environments, as well as the PPA in swimmers aiming at the best performance in the shortest time possible.

4 DISCUSSION OF THE DATA

From the data collected and presented during the course of the paper, the true hypothesis was refuted and the alternative hypothesis was confirmed based on the tests protocoled in the research.

Considering that the objective of this study was to compare different PPA protocols and their relationship with the 25-meter *sprint* in freestyle swimming, it was found that the protocols applied influenced the *sprint* time and, based on the tests, it was possible to indicate that the improvement in performance after aquatic PPA was superior to that observed after terrestrial PPA.

The study of Abbes (2018) tested the performance of PPA in aquatic environment and three conditioning protocols in terrestrial environment, these occurred ten minutes before the specific activity of swimming *sprints.* The tests indicated no improvement in performance compared to the control group that performed only the specific warm-up in water and waited to perform the activity, without performing the PPA.

It was verified, therefore, that there was no difference in the performance for 50m free swimming, due to the stimulus time of the conditioning activity. This result correlates with this research because the "Control" protocol was more effective than the other two performed with PPA interference. Thus, the result was similar, but the goal was to compare the types of PPA. From this, it was found that the aquatic type favored performance and was responsible for shorter 25-meter *sprint* times in freestyle swimming.

It is important to control the interval time used in the research, the longer the period between the end of the conditioning activity and the power exercise to be evaluated, the lower the rate of fatigue. On one hand it is beneficial because it decreases the occurrence of fatigue, however, the loss of the potentiation mechanism may occur (SALE, 2002).

The author Hamada (2000) had demonstrated that in endurance trained athletes, PPA was increased after the suggested conditioning stimulus and that the ability to resist fatigue (related to endurance training) could have contributed to this increase in PPA. This increased ability to resist fatigue could be related to muscle adaptations from training in muscle fibers.

For this reason, the study was carried out with individuals who had been swimming for a year, and the interval used in the methodology was eight minutes, aiming to benefit the muscular adaptations of the training and to increase the PPA while avoiding the fatigue related to the intensity of the protocols.

According to Young (1998), PPA can be understood as a rapid increase in strength and power in the muscle after a high intensity conditioning practice. Of the 19 participants, 13 had the best *sprint* time in the "Control" protocol with just the standard warm-up, two people (men) improved their time after the aquatic PPA, and four (two men and two women) decreased their time after the land PPA. Therefore, 68% of the times obtained in the "Control" protocol were better than the *sprints* done after the post-activation potentiations, both the land and aquatic ones.

Table 2 - Statistical analysis of the data found in the tests

THE EFFECT OF POST-ACTIVATION POTENTIATION ON SPRINTING IN FREE SWIMMING					
NAME	AGE GROUP (years)	PRACTICE TIME (years)	TESTS		
			Control Protocol	Aquatic PPA	Land PPA
1	Between 30 and 40	Above 4	17"09	17"88	18"03
2	Between 30 and 40	Above 4	15"71	16"70	16"90
3	Between 30 and 40	Up to 2	21"61	23"01	21"70
4	Between 30 and 40	Above 4	20"82	21"90	20"77
5	Between 30 and 40	From 2 to 4	24"17	24"70	25"80
6	Between 30 and 40	Above 4	14"13	15"10	16"18
7	Between 30 and 40	Above 4	16"21	16"80	17"11
8	Between 30 and 40	Above 4	12"62	12"01	12"00
9	Between 30 and 40	Above 4	17"88	16"92	18"21
10	Between 30 and 40	Above 4	17"00	17"62	18"01
11	Between 30 and 40	Above 4	12"65	12"02	13"20
12	Between 30 and 40	Above 4	22"13	22"91	25"60
13	Between 30 and 40	Above 4	16"21	16"60	17"10
14	Between 20 and 30	Up to 2	16"13	17"18	16"03
15	Between 30 and 40	Above 4	23"08	24"90	27"01
16	Less than 20	Up to 2	25"01	25"11	25"70
17	Between 30 and 40	Above 4	20"08	21"13	20"99
18	Between 30 and 40	Above 4	12"70	13"78	12"13
19	Between 30 and 40	Above 4	12"02	13"90	12"80
AVERAGE	-	-	17,75	18,46	18,66
DEVICE-PADRON	-	-	4,133747	4,369864	4,70283

5 FINAL CONSIDERATIONS

It is common to find people who prefer aquatic warm-up before swimming lessons based only on common sense, as well as physical education teachers who reproduce this practice without scientific basis or reflection on the theme. With this study, it was possible to corroborate the use of aquatic PPA before swimming lessons or training, based on scientific and empirical support through the protocoled tests.

In the literature, it is more common to find researches of PPA with the target audience of men, so this research sought to expand the sample of tests and also to analyze separately the female and male sexes. However, there were no differences in the final result, the aquatic PPA was the best in the overall sample and in each sex as well.

Based on the tests performed, it was possible to understand that the "Control" protocol proved to be more effective than the other two that had the potentialization, however, among the PPAs, aquatic was the one that showed better results and shorter *sprint* times.

Thus, it is interesting to deepen the research on PPA and the various protocols, as well as the different sports that involve it. Besides being possible to replicate the present methodology, establish a larger sample size, use different established intervals, and also vary the target publics. Another alternative is to replicate the study with swimming competitors, aiming at a better performance in competitions through different warm-up protocols during training sessions. New studies are indicated to expand and complement the information obtained from this study.

REFERENCES

ABBES, Z.; CHAMARI, K.; MUJUKA, I.; TABBLEN, M.; BIBI, K.W.; HUSSEIN, A.M.; MARTIN, C.; HADDAD, M. Do *Thirty-Second Post-activation Potentiation Exercises Improve the 50-m Freestyle Sprint Performance in Adolescent Swimmers?* Front Physiol. v. 22, pp. 1464, 2018.

BARBOSA, A.; BARROSO, R.; JUNIOR, O. *Post-activation Potentiation in Propulsive Force after Specific Swimming Strength Training.* International Journal of Sports Medicine, v. 37, pp. 313-17, 2015.

BARBOSA T, M.; YAM, J.W; LUM, D.; BALASEKARAN, G.; MARINHO, D.A. *Arm-pull thrust in human swimming and the effect of post-activation potentiation*. Sci Scientific Reports, v. 21, nº10, pp. 8464, 2020.

CHIU, L.; FRY, A; WEISS, L.; Schilling, B.; BROWN, L.; SMITH, S..*Postactivation Potentiation Response in Athletic and Recreationally Trained Individuals*. Journal of strength and conditioning research / National Strength & Conditioning Association, v.17, no. 4, pp. 671-677, 2003.

DESCHODT, V.J.; ARSAC, L.M.; ROUARD, A.H. Relative contribution of arms and legs in humans to propulsion in 25-m sprint front crawl swimming. Eur. J. Appl Physiol. v. 80, p. 192-199. 1999.

GAITANOS, G.C.; WILLIAMNS, C.; BOOBIS, L.; BROOKS, SL. *Human muscle metabolism during intermittent maximal exercise.* Journal of applied physiology. V.75, pp. 712-9. 1993.

GOLAS, A.; MASZCZYK, A.; ZAJAC, A.; MIKOLAJEC, K.; STASTNY, P. *Optimizing post activation potentiation for explosive activities in competitive sports.* Journal of Human Kinetics. v. 52, pp. 95-106, 2016.

HAMADA, T., SALE, D. G., MACDOUGALL, J. D. *Postactivation potentiation in endurance-trained male athletes*. Medicine and Science in Sports and Exercise. Vol. 32, No. 3, pp. 403–411, 2000.

HODGSON, M.; DOCHERTY, D.; ROBBINS, D. *Post-activation potentiation: underlying physiology and implications for motor performance.* Sports Medicine, v. 35, pp. 585-595, 2005.

KILDUFF, L. P., CUNNINGHAM, D. J.; OWEN, N. J., WEST, D. J.; BRACKEN R. M., COOK, C. J. *Effect of postactivation potentiation on swimming starts in international sprint swimmers*. Journal of Strenght and Conditioning Research. V. 25, pp. 2418-23, 2011.

KILDUFF, L.P., OWEN, N., BEVAN, H., BENNETT, M., KINGSLEY, M.I.C., CUNNINGHAM, D. *Influence of recovery time on post-activation potentiation in professional rugby players*, Journal of Sports Sciences, v.26, pp. 795-802, 2008.

NEIVA, H.P.; MARQUES, M. C.; BARBOSA, T. M.; IZQUIERDO, M.; MARINHO, D. A. Warm-up and performance in competitive swimming. Sports Medicine. v. 44, n.3, p. 319-330. 2014.

RASSIER, D. E. & MACINTOSH, B. R. *Coexistence of potentiation and fatigue in skeletal muscle*. Brazilian Journal of Medicine and Biological Research, v.33, n.5, p.499-508. 2000.
SALE, D. G. *Postactivation potentiation: role in human performance*. Exercise and Sports Science Review. v. 30, pp. 138–143, 2002.

SARRAMIAN, V., TURNER, A., GREENHALGH, A. *Effect of Postactivation Potentiation on Fifty-Meter Freestyle in National Swimmers*. The Journal of Strength and Conditioning Research. / National Strenght and Conditioning Association, v. 29, pp. 1003-1009, 2015.

WEBER, K.; BROWN, L.; COBURN, J.; ZINDER, S. *Acute Effects of Heavy-Load Squats on Consecutive Squat Jump Performance*. Journal of strength and conditioning research / National Strength & Conditioning Association. v. 22, pp. 726-30, 2008.

WILSON, J. M.; DUNCAN, N. M.; MARIN, P.J.; BROWN, L.E.; LOENNEKE, J.P.; WILSON, S.M.C.; JO, E.; LOWERY, R.P.; UGRINOWITSCH, C. *Meta-analysis of postactivation potentiation and power: Effects of conditioning activity, volume, gender, rest periods, and training status*. Journal of Strength and Conditioning Research, v. 27, pp. 854-859, 2013.

YOUNG WB, JENNER A, GRIFFITHS K. Acute enhancement of power performance from heavy load squats. J Strength Cond Res 1998; 12: 82–84.