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***Full Length Research Paper***

# Comparison of metabolic and physiological responses to high-intensity interval exercises performed in the pool and the field for physical education students

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**ABSTRACT**

The aim of this study is to compare high-intensity interval running exercises for physical education students in the field and the pool in terms of their effects on anaerobic power and blood lactate. 20 amateur male athletes that is student at physical education department participated in this study on a voluntary basis (Age: 22 ± 4 years, Height: 176 ± 8 cm, Weight: 72 ± 10 kg). The participants were divided into two groups, which were the pool group (n = 10) and the field group (n = 10). The athletes, who participated in the study, were administered a training program consisting of high-intensity interval running in the pool and the field during a period of eight weeks. Wingate test was administered to the participants and their lactate measurements were obtained before and after the 8-week training program. Data obtained were analyzed using the SPSS 22.0 package program. In order to determine the chronic effect of the training environment on anaerobic capacity and lactic acid activation, the difference between the findings obtained before and after the training was calculated. The independent sample-t test was performed to determine the difference between the groups. According to the results, aquatic exercises produced more positive gains on anaerobic power and lactic acid activation; however, there was no statistically significant difference between the groups ($p > 0.05$). In conclusion, it can be argued that the trainings in the pool could be included in the training programs as an alternative to field training due to the physical properties of water; and better results can be obtained to a certain extent.

**Keywords:** Anaerobic power and capacity, deep water running, interval training, lactic acid, physical education.

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## INTRODUCTION

According to current understanding of sports performance, it is expected that the motions should lead to maximum performance in many sports branches. Anaerobic capacity (performance) is the main determinant of short-term and high-intensity physical activities at the maximum level. In the previous studies, it was often mentioned that the training level, age, gender, heredity, muscle type, mass and cross-sectional area, and body composition of the athletes affected their anaerobic performance (Aslan et al., 2011; USTUNDAĞ et al., 2017; Zorba et al., 2010). Improving anaerobic performance and achieving the maximum performance have been considered quite important by all stakeholders of the sports sciences. Anaerobic power parameters, which are one of the most important determinants of sports performance, are defined as the performance capacity created by skeletal muscles during the maximum physical activity by using anaerobic energy transfer systems in the absence of oxygen (Serin, 2018; Yilmaz and Müniroğlu, 2011).

The value of this performance per unit time is expressed as the anaerobic power. Rapid starts and direction changes in team sports such as weight training, weightlifting, discus throw, a 100-meter speed run,

basketball and football are important for the evaluation of anaerobic performance (Aydın et al., 2015; Çakmakcı, 2013; Ozan, 2013; Özkan and Kinişler, 2010). It is the main objective of coaches and conditioners to determine the strength and capacity of athletes and to prepare a training program accordingly to increase their performance. Therefore, different training methods have been tried in different environments. Accordingly, that the aqueous training could be an alternative to the traditional field training has been an attractive opinion in the recent years (Adar and Toktaş, 2019; Demirdal, 2012). Many athletes with global achievements try to improve their anaerobic capacities by making use of the physical properties of water (Volaklis et al., 2017). For instance, Usain Bolt, the holder of the 100 m World Record, is known to have trained in the pool while preparing for the Olympics.

The aim of our study was to compare the effects of high-intensity interval training performed the pool of a certain level of depth and in the field in terms of improving the anaerobic power and capacity in young and active individuals.

## METHODOLOGY

### Research model

This study has a longitudinal design and it consists of 2 parallel training groups. Twenty active male participants were divided into two groups randomly. Both the pool group (PG; n = 10) and the field group (FG; n = 10) were trained in a total of 24 training sessions 3 days a week during a period of 8 weeks. Wingate and lactic acid tests were performed before and after the training. The Wingate test was performed and after the training. Next, a blood sample was obtained from the fingertip for the lactic acid test.

### Universe and sample of the research

This study was participated on a voluntary basis by 20 amateur and active male athletes (n = 20), who were aged between 22 ± 4 years. All necessary permissions were obtained from the ethics committee of Atatürk University in accordance with the Helsinki Declaration. None of the participants had any health problems preventing cardiovascular training or exercise. After the participants were informed about the training program and the experimental design of the study, informed consent forms were obtained.

### Training program

High-intensity interval training running program was administered to all participants in pool and in athletics track (Table 1). The duration of the training programs was about 40 minutes (10 minutes of warm-up, 20 minutes of high-intensity interval training, and 10 minutes of stretching movements). The training sessions were monitored by an experienced researcher.

**Table 1.** Training groups and training program.

| Before training | Pool group<br>Field group | | After training |
|---|---|---|---|
| Wingate test | 30 sec run | 20 times | Wingate test |
| Lactic acid test | 30 sec rest | | Lactic acid test |

### Testing procedures

#### *Wingate anaerobic power test*

The Wingate anaerobic test is one of the tests that determine the anaerobic characteristic, which provides information about both lactacid (average power) and alactacid (peak power) components of anaerobic performance. Following the 5 minutes of warm-up protocol, the participants were administered the test protocol consisting of 2 minutes of recovery, acceleration and cooling exercises following Wingate test. The fatigue index, which means the expression of the power decline during the test in percentage, was calculated by using the test results according to the following formula (Koşar and Hazir, 1994):

Fatigue index (FI) = ((peak power output - minimum power output) / peak power output) × 100)

#### *Lactic acid test*

The Wingate test was performed before and after the training program for a period of eight weeks. Immediately after the Wingate test, blood samples were obtained from fingertip for the lactic acid test. Analysis of blood samples obtained was performed using lactate plus (Nova Biomedical, USA) measurement analyzer designed to evaluate athletic performance. The blood

samples were analyzed immediately by dripping on the strip.

### Statistical analysis

Data were analyzed using the SPSS 22.0 package program. The difference between the data obtained from the test before and after the training was determined. Shapiro-Wilk test was used to analyze the compliance of the differences with the normal distribution. It was observed that the data had a normal distribution. Independent groups t test was performed to determine the chronic effect of the environment, in which the training program was administered, on the improvement of anaerobic power (Taşpinar, 2017).

## RESULTS

### Lactic acid

When the training groups were compared according to the results we obtained, there was a mathematical decrease in the lactic acid values of the pool group in terms of the training environment; however, no statistically significant difference was observed between the groups. p = .211 (p > .05; in Table 2).

**Table 2.** Independent t test results.

| Variables | Deep water running | Field running | p |
|---|---|---|---|
| Lactate Measurement Posttest/Pretest Difference | -1.47±1.68 | -.41 ±1.98 | .211 |
| Wingate Fatigue Index Posttest/Pretest Difference | 5.87 ±9.54 | 1.46 ±4.56 | .204 |

### Wingate anaerobic power test

There was no significant difference between both groups in terms of their mean fatigue index values before and after the training (p = .204; p > .05, respectively, in Table 2). The absence of a significant difference in the training environments of both groups could indicate that similar gains were obtained in both groups.

## DISCUSSION

It has frequently been mentioned by professional athletes or individuals who perform recreative sports in recent years that aqueous exercises could create an alternative environment to field training in terms of improving physical performance due to the physical properties of water. There have been many studies evaluating the physical properties of water in this respect. There is considerably few numbers of studies directly comparing the high-intensity interval training performed in the water and in the field in terms of their effects anaerobic capacity and lactic acid activation in the same groups, as we discussed in the present study. The findings we obtained as a result of the study demonstrated that high-intensity interval training performed for 8 weeks resulted in similar gains in the anaerobic performance of both groups after training compared to the anaerobic performance before the training. There have been gains within the groups; however, the difference between the groups was not statistically significant.

Looking at the literature on the subject, we observed that the previous studies mainly focused on the results of the exercises performed with the aim of improving the health status of patients rather than improving the performance (Reilly et al., 2003). For instance, Guvenir carried out a study in 2007 by Guvenir with 89 females aged between 50 and 65 years diagnosed with bilateral knee osteoarthritis and examined the right and left quadriceps femoris muscle strength values (Güvenir, 2007). There was no difference between the groups before the treatment performed in water, while the quadriceps femoris muscle strength values of the individuals who exercised in water were higher after exercise compared to the control group (Güvenir, 2007). In a study conducted with basketball players by Asadi in 2013, it was found that aqueous exercises had a positive effect on young basketball players in terms of their muscle strength and agility (Asadi, 2013). In a study carried out in 1984 on patients with Multiple-Sclerosis, Gehlsen stated that aqueous exercises affected the muscle powers of the patients positively (Gehlsen et al., 1984). In the literature, studies have often reported that aqueous exercises improved general health of patients and provided improvement of strength. It can be argued that these results are partially similar to the findings of our study. In terms of physiological performance, higher efforts are required in the aqueous exercises due to the higher fluid resistance of water compared to the air. In a study conducted by Stephen Payton in 2018, it was

reported that it was necessary to produce four times higher power in aqueous exercises in order to achieve the same movement speed as the exercises performed in the field (Payton, 2018). Therefore, blood lactate activation was higher in aqueous exercises compared to exercises performed in the field. When compared to the field group, it was stated that lower blood lactate results were obtained in the aqueous group in the Wingate test performed after the eight-week training program. Maaroos et al. (2003) conducted a low-intensity aerobic training in water for 12 weeks in their study. In another study we found in the literature, it is reported that all participants in the exercise group both water and land improved similarly their cardiovascular reserve and physical capacity (Volaklis et al., 2007). This improvement may support the improvement of the lactate tolerance in participants, which is similar to our study.

## CONCLUSION AND RECOMMENDATIONS

It can be concluded from our results that the physical properties of water have a slightly positive chronic effect on the improvement of performance and on accumulation of lactic acid, which is an indicator of fatigue affecting the anaerobic capacity.

### Highlights

Aqueous exercises can be included in the training programs of athletes due to the effects of the physical properties of water on physical performance.

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### Conflict of interest statement

The author reports no conflict of interest. The author declares that the results of the study are presented clearly, honestly, and without fabrication, falsification, or inappropriate data manipulation.

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