International Journal of Internet, Broadcasting and Communication Vol.14 No.4 222-227 (2022)
http://dx.doi.org/10.7236/IJIBC.2022.14.4.222

IJIBC 22-4-26

Effect of different underwater recovery methods on heart rate after circuit weight training

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Abstract

The purpose of this study was to investigate changes in heart rate according to recovery methods after circuit weight training exercise. Fourteen men in their twenties were selected as subjects, and three sets of circuit weight training were performed by cycling six sports, and two recovery conditions (dynamic and static) were performed immediately after exercise. Changes in heart rate did not have an interactive effect according to recovery method and time, and both conditions showed significant changes between sets 1 and 2, and between sets 3 and after recovery. In this study, the high heart rate of 2 sets and 3 sets was seen as a result of exercise stimulation, and the low heart rate of 1 set was thought to be due to the decrease in vagus nerve activity rather than the role of catecholamines. On the other hand, the heart rate after 20 minutes of exercise did not show any difference according to the recovery method, which could mean that the recovery process due to the aquatic environment can act more strongly than the process of dynamic recovery and static recovery. It is thought that the characteristics affected the sensory and circulation of the body, and thus the change of the afferent signal and the level of metabolic products generated in the active muscle.

Keywords: *Circuit weight training, underwater dynamic recovery, underwater static recovery heart rate*

1. Introduction

Recovery is defined as the restoration of muscles to their pre-exercise state during exercise [1]. , hydrostatic pressure increases the removal of metabolic products by changing the constriction of peripheral blood vessels, thus helping recovery [2]. Resting without any activity throughout the recovery period is called static (stability) recovery, and light exercise during recovery period is called dynamic (motility) recovery [3]. Among the methods of many studies, it can be divided into dynamic recovery and static recovery. Among the two methods after exercise, blood lactate removal rate showed that dynamic recovery showed faster lactate removal rate than static recovery [4]. Through active recovery exercise, light aerobic exercise is effective in preventing excessive blood release and reducing muscle pain to quickly release metabolic waste [5]. On the other hand, as a support for static recovery, inactivity recovery not only increases the rate of return to the baseline of

Manuscript Received: October. 20, 2022 / Revised: October. 25, 2022 / Accepted: October. 27, 2022
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oxygen uptake, but also accelerates heart rate recovery [6]. The aquatic environment can use various fluid properties such as underwater buoyancy, hydrostatic pressure, density, external current, and water temperature, and the effect of reducing pain and muscle tension can be obtained by the temperature of the water [7]. When entering the hot or cold bath, capillaries, aorta, and veins expand, increasing blood flow and blood volume in the hands and feet, so the resistance of peripheral blood vessels decreases. Implementing the recovery method in water is expected to maximize the recovery effect [8]. Heart rate is one of the bio-signals that can be observed relatively conveniently during exercise, and heart rate increases due to vagus nerve suppression at the start of exercise [9]. In addition, the heart rate is sensitive to momentum or exercise intensity, and decreases as the afferent signals of muscles and joints stop shortly after exercise [10]. Water immersion is increasingly being used by elite athletes seeking to minimize fatigue and accelerate post-exercise recovery, A study to verify the recovery effect of the actual underwater environment [11] and a study to compare the recovery effect according to the water temperature [12] are being carried out. In the ground condition, static recovery and dynamic recovery [13], massage and vertical recovery [14] And so on. On the other hand, there is no research on how to recover in the underwater environment, and there is no research on dynamic recovery and static recovery through underwater movement. The purpose of this study is to compare and analyze changes in heart rate during dynamic recovery and static recovery in the aquatic environment and contribute to the construction of data for underwater recovery guidelines after exercise.

2. Experiment Materials and Methods

2.1 Subject

The study was conducted on 14 healthy men in their 20s who were attending C city D university. The researcher fully explained the significance, purpose and procedure of the study to the subjects, and selected only the subjects who voluntarily signed their own autographs in the consent for participation in the study while they were fully aware of the contents of this study. In order to obtain accurate research results, before the experiment, moderate or higher physical activity was refrained from smoking and drinking. The characteristics of the subjects are as shown in Table 1.

Table 1. Characteristics of the subjects

	Height(cm)	Weight(kg)	Age(year)	exercise career (year)
N=14	177.00±3.62	80.51±9.05	31.37±4.22	3.74±1.04

2.2 Study Design

This study was conducted at A City D Spa, and the subjects exercised once a week for 2 weeks in 2 recovery conditions (dynamic recovery in water, static recovery in water) after ground circuit weight training exercise. Heart rate was measured immediately after each set exercise (sets 1-3) and immediately after recovery.

2.3 Circuit weight training Method

As circuit weight training, the subjects performed 6 exercises with an intensity of 60% of 1RM 3 times. 1 lying triceps extension, 2 barbell squat, 3 barbell curl, 4 barbell shoulder press, 5 lateral raise, and 6 barbell row. , the rest period between sets was 3 minutes.

2.4 Underwater recovery

After exercise, two recovery methods were performed: dynamic recovery in water and static recovery in water, and both conditions were conducted at a water temperature of 34°C. The first underwater dynamic recovery is a recovery method, and the recovery of walking at waist height was performed by walking for 20 minutes at a speed of 3 km/h in water at the same water temperature and taking a break. The second underwater static recovery was performed while sitting on a chair without movement in the water.

2.5 Heart rate measurement

For the heart rate, the instantaneous heart rate was measured between exercise sets, and the instantaneous heart rate was measured after recovery for 20 minutes, and measured 4 times per experiment for a total of 8 times. A wireless heart rate sensor (Polar, Finland) was used as a measuring device, and the sensor was placed in the Xipohid process of the chest and then measured in conjunction with polar beat software (ver. 3.3.3, Polar Electro).

2.6 Statistical Analysis

For data processing measured in this experiment, the mean and standard deviation of all variables were calculated using the IBM SPSS Statistics (ver 22.0) statistical program. All variables were analyzed by repeated measurement two-way ANOVA method. In case of significant difference, post-hoc was conducted by using Bonferroni method. Statistical significance level was set to =.05.

3. Result

3.1 Change of Heart rate

There was no interaction effect according to the recovery method and time, and both conditions showed significant changes between the 1st and 2nd sets, and the 3rd set and after recovery. Table 2 shows the results of repeated measurement bivariate analysis for heart rate.

Table 2. Change in heart rate(HR)

Category	1set	2set	3set	Posr 20min	two-way ANOVA		
						F	*p*
dynamic	116.25±21.25	137.65±23.37†	144.12±19.68†	100.79±14.19†∫§	Condition	.006	.938
static	115.54±23.65	134.50±24.54†	143.07±20.58†	93.30±12.32†∫§	Time	.475	.505
					C x T	.000	.987

†Significant difference to set 1.

∫Significant difference to set 2.

§Significant difference to set 3.

‖Significant difference to set 4.

4. Discussion

According to previous studies related to recovery on the ground, static recovery is more positive in terms of heart rate because it acts as an exercise load rather than a recovery depending on the strength during dynamic recovery [15], [16] reported that heart rate, blood pressure, and cortisol concentration decreased when walking or resting in a forest environment. In addition, it was reported that the dynamic recovery type was more positive for the recovery rate of blood lactate concentration over time after exercise than the static recovery type [17, 18]. Submerged immersion is divided into four techniques according to water temperature: cold water immersion (CWI, ≤20 °C), hot water immersion (HWI, ≥36 °C), control therapy (CWT, CWI and HWI alternating), and thermal neutrality. Immersion (TWI; >20 to <36 °C). Numerous articles have reported that CWI can improve performance recovery in a variety of sports, including immersion in water at 10-15°C for 5-15 minutes appears to be most effective in accelerating performance recovery. Therefore, the purpose of this study is to compare the recovery conditions in the water, unlike previous studies such as ground recovery conditions, underwater recovery conditions, recovery according to water temperature, and massage. The purpose of this study is to analyze the changes in heart rate during exercise performance and recovery by using underwater recovery (dynamic and static) after circuit weight training. Cardiovascular action is regulated by the heart's machinery, chemoreceptors, muscle's mechanoreceptors, and blood pressure-sensitive receptors between the aorta and the carotid arch [19]. From the end of the exercise, the heart rate is lowered to the level of stability, which can be attributed to the hyperactivity of the parasympathetic nerve [20]. Heart rate recovery by the parasympathetic nerve immediately after exercise is relatively rapid [9], and joint receptors such as the near-fusiform spine and the Golgi tendon also control the cardiovascular response by sending information about the load and movement on the muscles to the cerebral center [10]. Therefore, after exercise, the heart rate may decrease sharply due to the action of the joint receptor, which is mainly due to the stoppage of the afferent signal from the compression receptor of the muscles and joints. The subsequent decrease in heart rate is known to be caused by a decrease in excitatory stimuli to the heart motor center due to a decrease in myocardial temperature, metabolism of circulating epinephrine, and a decrease in lactic acid levels in body fluid [21]. In the results of this study, there was no interaction effect according to recovery method and time, and both conditions showed significant changes between 1 set and 2 sets, 3 sets and after recovery. When exercise begins, it begins to rise due to mechanical contraction of the muscles and chemoreceptor reflexes in the carotid arteries and aorta due to increased reflux venous blood, and increases to about 130 times/minute levels due to decreased vagal action, increased sympathetic activity, and catecholamines [22, 23]. At this time, the increased heart rate is caused by the hypertrophy of the sympathetic nerve, but mainly occurs when the tension of the vagus nerve decreases. Therefore, in this study, the high heart rate of 2set and 3set was shown to be the result of motor stimulation, and the low heart rate of 1set was attributed to the decrease of vagal activity rather than the role of catecholamine. On the other hand, the heart rate after 20 minutes of exercise did not show any difference according to the recovery method, which means that the recovery process due to the underwater environment may be more powerful than the process of dynamic recovery and static recovery. It is considered that the characteristics of water such as hydrostatic pressure and water temperature affect the sensory and circulation in the body, which may affect the change of afferent signals and the level of metabolic products generated in the active muscle. In a previous study that studied underwater recovery, it was reported that the heart rate recovered to a level close to rest (81.5 to 94.2 bpm) as a result of performing recovery in water for 20 minutes after exercise [24]. This is because the hydrostatic pressure acting on the body stimulates the parasympathetic nerve activity by stimulating the baroreceptors existing as cardiopulmonary and aortic receptors by moving peripheral blood toward the heart [25].

5. Conclusion

This study investigated the heart rate according to the recovery method after circuit weight training exercise and showed the following results. Changes in heart rate did not have an interactive effect according to recovery method and time, and both conditions showed significant changes between sets 1 and 2, and between sets 3 and after recovery. In future studies, it seems that follow-up studies under various conditions such as different water temperature and depth are necessary, and it is expected that follow-up studies will be conducted through the addition of various variables that can evaluate recovery.

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