Jurnal SPORTIF: Jurnal Penelitian Pembelajaran
Vol. 7 No. 3, December 2021, pp. 467-479
https://doi.org/10.29407/js_unpgri.v7i3.16859

The effectiveness of active recovery (jogging and cycling) post-football match simulation on athletes' heart rate and fatigue levels

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Received: 30 November 2021; Revised: 1 December 2021; Accepted: 7 December 2021

Abstract

Active recovery is recommended to help the soccer player recover quickly. However, there has been no study comparing the most effective active recovery methods post-match. The purpose of this study was to compare active recovery (jogging and cycling) to the heart rate and fatigue level of athletes. This study uses an experimental method with a pretest-posttest crossover design approach. Subjects were 22 male amateur football athletes with an average (age, 19.40 ± 1.18 years; height, 170.04 ± 3.54 cm; weight, 62.89 ± 5.44 kg). The results showed that the average heart rate (HR), vertical jump (VJ), and lactate levels between groups after the simulation match did not show significant differences (HR p= 0.748, VJ p=0.984, lactate p=0.633). However, for variables HR and lactate levels experienced a significant decrease after undergoing recovery treatment, and when viewed from the delta the jogging group experienced a decrease (HR 24.7%, and lactate 52.5%), for the bicycle group (HR 29.3%, and lactate 60.9%) and the sitting group (HR 19.91%, and lactate 23.4%). So the results of this study provide evidence that post-match cycling can contribute to a more effective active recovery strategy. Thus the results of this study can be used as a reference for coaches and athletes in a good recovery process after a football match.

Keywords: active recovery, cycling, jogging, recovery strategy, football

INTRODUCTION

Football is an intermittent sport with high intensity, so athletes are required to maintain physical fitness during the competition (Joo, 2018). In football matches, elite athletes can run at high speeds as far as 587 ± 133 m (19.8 - 25.1 km/h) (Carling et al., 2016). However, the total distance running at such high intensity depends on the position of the players and the level of the match. Professional football players often run at a higher intensity when compared to semi-professional football players (Mohr et al.,

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2003). Thus, high physical performance is an important factor in determining the success of a football team.

In addition to high physical performance, football players are also faced with a hectic match schedule, where players are required to practice repeatedly in a short period. So the quantity of exercise that is carried out intensively and excessively with a quick recovery time can place great physiological demands on the musculoskeletal, nervous, immune, and metabolic systems that can potentially cause negative effects on subsequent performance (Reilly & Ekblom, 2005), and can affect some players sustain followed-up injuries (Dupont et al., 2010). Previous research revealed that the accumulation of fatigue in a football athlete could be caused by the repetition of matches and exercises performed in a short time (e.g., daily training with match schedules separated by <48 hours) (Dupont et al., 2010).

Furthermore, according to (Dupuy et al., 2018) explain that maximizing an athlete's performance is not only a matter of training but is also influenced by various intrinsic and extrinsic elements. Current evidence highlights that adequate and optimal recovery is required to prevent injury and decrease athlete performance (Minett & Costello, 2015). Appropriate recovery strategies can help athletes achieve better performance and can help athletes achieve rest goals (Phillip et al., 2008). Therefore, coaches and athletes must constantly search for the most effective strategies to speed up post-match recovery.

Establishing the importance of recovery, several studies have shown that active recovery, such as low-intensity jogging, is more effective than passively stretching only after physical activity (Ben Abderrahman et al., 2013; Shimoyama & Wada, 2015). Furthermore, when associated with lactate, active recovery has a more positive impact on reducing lactate due to fatigue during exercise (Kappenstein et al., 2015; Lopes et al., 2014), although one discusses the effects of sprint repetition training (Kappenstein et al., 2015) and power (Lopes et al., 2014). More specifically, the previous research that underlies the emergence of this

https://doi.org/10.29407/js_unpgri.v7i3.16859
7 (3) 2021 | 467-479

ISSN : 2477-3379 (Online)
ISSN : 2548-7833 (Print)

research idea was obtained from how two types of active recovery were obtained, namely the use of bicycles that utilize the lower muscles and the use of bikes that use the arm muscles on muscle performance after experiencing exercise fatigue in canoe athletes and football players (Mika et al., 2016). The study concluded that 20 minutes of active recovery after an exercise involving the same muscles and experienced fatigue during training was more effective in recovery than operational activities using forces not engaged during the previous exercise (Mika et al., 2016). It can be concluded that it is less effective for muscle recovery when a football athlete recovers with arm exercises. Therefore, the part of the body which is involved during physical activity, during recovery, that part of the body will be given more time for active recovery.

From the results of previous studies mentioned in the paragraphs above, briefly, the urgency of this research must be carried out since most of the earlier studies have only compared active and passive recovery, there are still few that have been explored further and specifically focused on functional recovery that relies on comparisons between two types of activity: jogging and cycling.

Therefore, this study is aimed to investigate the effectiveness of post-exercise recovery using active recovery methods (jogging and cycling). So that it can determine which one can more dominantly affect the physiological (lactate and pulse) and motor (vertical jump) aspects after conducting a match simulation, this is expected to be a new option for coaches who are limited in facility support, to be able to apply the use of other sports as an alternative to recovery.

METHOD

The method used in this study is a quasi-experimental method with a pretest-posttest one-way crossover design approach where all research subjects will be given the same three recovery treatments (jogging, cycling, and resting in a sitting position) separated by a distance of seven days as a washout between recovery treatments. Recovery treatment will be carried out after the subject performs a football match simulation with a

https://doi.org/10.29407/js_unpgri.v7i3.16859
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time of 45 minutes x 2 rounds without any substitutions, and the parameters measured in this study include vertical jumps, blood lactate levels, and the average postoperative heart rate (HR) after performing a match simulation. Some of these parameters will be taken after the subject runs a match simulation (as pretest data) and after undergoing recovery treatment (as posttest data).

The total subjects were 22 male amateur football athletes with mean (age, 19.40 ± 1.18 years; height, 170.04 ± 3.54 cm; body weight, 62.89 ± 5, 44 kg; BMI, 21.74 ± 1.71 kg/m-2; FAT, 12.17 ± 1.26%) that were volunteered for this study (see table 1). Inclusion criteria for selecting subjects in this study included no history of chronic disease, at least four years of practice experience, did not take supplements for at least the last one month, and exercised at least 2-3 times per week for the last three months. All research subjects were given written, and oral explanations regarding the research procedures, and subjects were asked to read and sign the informed consent.

Measurement and Research Procedure

Anthropometric

Anthropometric data retrieval, including age, was carried out using a questionnaire filled out independently by the subject. Furthermore, the height data was using a stature meter, while for body weight, BMI, and FAT of athletes, it is measured using the OMRON Karada Body Fat Scan tool (HBF-375). The anthropometric data was taken before the subject underwent the simulation trials and recovery treatment.

Vertical jump

The vertical jump height was measured using Vertec (SPRI Commercial SKU: 07-70250). Vertec is a vertical jump measuring instrument in the form of a pole with a horizontal arrangement of a number of irons such as vanes, and the distance between the vanes is about 1 inch. The lowest vane is adjusted to the height of the subject in a standing position with the right/left arm straight up. The jump height is calculated

https://doi.org/10.29407/js_unpgri.v7i3.16859
7 (3) 2021 | 467-479

ISSN : 2477-3379 (Online)
ISSN : 2548-7833 (Print)

from the highest vane reach by hand that can be reached when the subject jumps.

Lactate level

The lactate level in the blood is done by taking a blood sample from the subject's fingertip with a test strip and directly analyzing using an acquired Plus Portable analyzer. The data collection was carried out twice, namely post-simulation and post-recovery treatment.

Active recovery (Jogging and bicycle)

Active recovery data retrieval was carried out after the match simulation, where all subjects tried to do jogging and cycling trials for 20 minutes with low intensity (<65% of Hrmax) (Mika et al., 2016). Heart rate data will be taken when the subject is undergoing recovery treatment using a Polar Heart Rate Monitor (Polar H10 Heart Rate Sensor, Inc., USA).

Passive recovery (taking rest in a sitting position)

Passive recovery data retrieval was carried out after the match simulation. All subjects tried to do a trial by resting in a sitting position without doing any activity for 20 minutes.

Research Procedure

The procedure in this study, namely, all subjects took anthropometric measurements at the initial stage, which included Age, Height, Weight, BMI, and FAT. Furthermore, participants perform a match simulation with 45 minutes x 2 rounds without substitutions. After the match simulation, all subjects were collected data, including blood lactate, vertical jump, and 20-meter sprint. After performing the match simulation, all subjects carried out three recovery treatments together: jogging, cycling, and sitting at low intensity for 20 minutes. The three treatments were separated by seven days as a washout process. Parameters such as blood lactate, vertical jump, and 20-meter sprint will be taken after the subject performs recovery treatment.

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DATA ANALYSIS

The data was presented in the form of average and standard deviation. The analysis of significance per group was using one-way ANOVA or one-way test. Meanwhile, the researcher used an independent T-Test to compare all the treatments. All statistical analysis tests used SPSS version 25 with a significance level ($p < 0.01$ or $p < 0.05$).

RESULT

Table 1 shows that the results of the research subject data were analyzed descriptively quantitatively, the data included Age, Height, Weight, BMI, and FAT. The findings in this study did not show any significant differences in the standard deviation between individuals.

Table 1. Anthropometric Data

Variable	Experiment (N=22)		
	Mean (SD)	Min	Max
Age (yr)	19.40 ± 1.18	18.00	21.00
Height (cm)	170.04 ± 3.54	162.50	179.50
Weight (kg)	62.89 ± 5.44	52.50	71.50
BMI (kg/m^{-2})	21.74 ± 1.71	18.94	25.79
FAT (%)	12.17 ± 1.71	10.40	15.20

BMI = body mass index

Table 2. Physiological Characteristics

Variable	Jogging (N=22)		Cycling (N=22)		Sit (N=22)	
	Pasca-S	Post-T	Pasca-S	Post-T	Pasca-S	Post-T
Hear Rate	182.27 ± 3.63	137.14 ± 7.47*	181.37 ± 3.64	128.21 ± 9.91*	181.74 ± 2.34	145.55 ± 8.59
V. Jump (cm)	47.50 ± 2.57	49.40 ± 2.87*	47.63 ± 2.57	51.36 ± 2.42*	47.59 ± 2.53	48.52 ± 2.60
Lactate (mmol/l)	10.89 ± 0.87	5.17 ± 0.61*	10.62 ± 1.12	4.15 ± 0.69*	10.87 ± 1.11	8.32 ± 1.14

Pasca-S = Post-match Simulation, Post-T = Post *Treatment*
*significance $p < 0.05$

The results showed that the average heart rate (HR), vertical jump (VJ), and lactate levels between groups after the simulation match did not show a significant difference (HR p = 0.748, VJ p = 0.984, lactate p = 0.633). But HR and lactate levels significantly decreased after undergoing the recovery treatment, where when viewed from the delta, the jogging

https://doi.org/10.29407/js_unpgri.v7i3.16859
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ISSN : 2477-3379 (Online)
ISSN : 2548-7833 (Print)

group experienced a decrease (HR 24.7%, and lactate 52.5%), then for the bicycle group (HR 29.3%, and lactate 60.9). %) and the sitting group (HR 19.91%, and lactate 23.4%).

Furthermore, the vertical jump variable between groups significantly increased after the recovery treatment, but not for the group that received the sitting recovery treatment (p=0.001 jogging, p=0.001 bicycle, sitting p=0.830).

DISCUSSION

Fatigue that occurs due to exercise requires time to rest to replenish the energy that has been drained during activities. There are two forms of recovery, namely active and passive, which are usually done before and after exercise. Active recovery is carried out to accelerate recovery during the rest periods, aiming to increase blood flow in the muscles, remove lactate, and allow the formation of phosphocreatine (Shimoyama & Wada, 2015). We often see in daily activities during physical activity. There are still many tendencies of sports activists after completing a physical activity. They continue to sit or lie down suddenly. Suppose it is related to the theory, about 75-80% blood flow when doing physical activity or strenuous exercise (Kenney et al., 2015), In that case, blood will flow to the muscles to supply the cardiovascular system during the activity. If what is done is a lower-dominant extremity sport, then when someone suddenly stops, there will be an accumulation of blood in the muscles of that part of the body. Some mistakes occur, such as sitting or sleeping right after exercising. This causes a slight shock to the cardiovascular system, especially the blood circulation. There is an accumulation of blood in the lower extremities, causing tingling or dizziness symptoms (Kenney et al., 2015; Sharon A. Plowman, 2017). Exercise performance can be restored by adjusting the muscle temperature, it is more effective by heating the muscle temperature compared to cooling the body temperature because it is influenced by accelerating and slowing the decrease in muscle temperature (Cheng et al., 2017).

https://doi.org/10.29407/js_unpgri.v7i3.16859
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This study proves that the average heart rate (HR), vertical jump (VJ), and lactate levels between groups after the match simulation did not show a significant difference. However, HR and lactate levels had a significant decrease after undergoing recovery treatment. When viewed from the delta, the jogging group had a decrease (HR 24.7%, and lactate 52.5%), then for the bicycle group (HR 29.3%, and lactate 60.9). %) and the sitting group (HR 19.91%, and lactate 23.4%). The results of this study specifically prove that after it is known that active recovery is better than passive, furthermore, the selection of recovery using a bicycle is better than jogging and sitting (passive), with the use of a recovery time of twenty minutes based on previous studies (Mika et al., 2016), where active activity is given to the same muscles used during core training. Both (jogging and cycling) show a decrease in the fatigue index, but if you have to explain which option is better, then the choice is to choose active recovery by cycling, especially for football athletes (Mika et al., 2016). The active recovery that is carried out can certainly reduce the pulse rate due to the decreased intensity and the same movement as core exercises where the focus is on the lower extremity body, as mentioned in the previous study, so that individuals are better prepared to carry out the next movement with a recovered body condition so that they can obtain a better increase in vertical jump achievement (Pontes Morales et al., 2014). If we examine the similarity of the muscles used when playing football and cycling, there are similarities in the dominance of bodywork in the lower extremities. In addition, it has the advantage of a lighter workload compared to jogging. The assistance of the bicycle frame and pedals while cycling, which can be adjusted according to the wishes and abilities of the subject, can affect the time when experiencing fatigue and the long duration of recovering the body back to its original condition. In football, there are many kinds of muscle recovery strategies, such as passive, stretching, active, and foam rollers (Rey et al., 2019) and cold-water immersion (Babak et al., 2021; Cheng et al., 2017).

https://doi.org/10.29407/js_unpgri.v7i3.16859
7 (3) 2021 | 467-479

ISSN : 2477-3379 (Online)
ISSN : 2548-7833 (Print)

AAnother study discussed how increasing VO_{2Max} values occurred better in the active recovery group than in the passive group through an intensive training program through the HIIT (High-Intensity Interval Training) method within seven weeks (Ben Abderrahman et al., 2013). The presence of acute or prolonged effects provided by active recovery is beneficial in improving the function of the nervous system and muscles, reducing lactate rapidly (Akagi et al., 2020; Lopes et al., 2014) and is effective in reducing fatigue (Mika et al., 2016). Referring to the results of previous studies, it is recommended that active, passive recovery, and a combination of both can be applied in a more specific and effective exercise program (Bernal-Orozco et al., 2020) to suit body composition and anthropometry. So that the selection of active forms of exercise such as jogging and cycling is made.

In the last twenty years of studies, it was stated that the combination of an active and passive recovery in recent studies was said to be more effective in overall recovery (Monedero & Donne, 2000). However, over time, many changes have occurred. Many studies state that active recovery is better used after exercise than passive recovery (Akagi et al., 2020; Lopes et al., 2014; Maior et al., 2020; Mika et al., 2016). However, one previous study stated that there was no difference in the effect between passive and active recovery after exercising. Even though it is more specific, passive recovery has been shown to have a longer time to exhaustion than active recovery (Mulyawan, 2020) although indeed, the study was not investigated on the effectiveness of energy fulfillment for the next exercise. This is supported by if a person is in a state of fatigue and is required to do repetitive work, then active recovery does not have a good effect since if it continues, it will cause fatigue, and the body will not recover quickly (Shi et al., 2018). In contrast to the statement about passive recovery strategies, it reduces the ability to maintain repeated maximal intensity cycling performance (Kumstát et al., 2019) It is different from active recovery, where it better affects readiness to carry out continued and repetitive physical activities or movements.

https://doi.org/10.29407/js_unpgri.v7i3.16859
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Therefore, the recommendation for active recovery and a combination of the two is still superior compared to just passive. More specifically, in line with the statement that emphasizes the use of the same muscle work during recovery and core training (Mika et al., 2016), causing the use of jogging and cycling to be very beneficial, but when viewed specifically, the results are using bicycles as an active recovery option which is recommended to be a reference after the individual experiences fatigue.

CONCLUSION

Cycling during the recovery period after the match is recommended to recover faster due to fatigue compared to jogging and sitting (passive), especially in football athletes. Active recovery is more recommended after training or a match than passive recovery.

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