http://jrhc.miau.ac.ir

Report of Health Care **Original Article**
Volume 2, Issue 1, 2016, p. 46- 54

The Recovery Effect of Cold Water Immersion and Massage on the Physical Performance of Young Male Soccer Players

Babak Mostafa Farkhani [1], Mehdi Javadi Kia[1], Keyvan Hejazi [2], Mehrdad Fathi [1], Seyed Reza Attarzadeh Hosseini [1], Mohammad Mosaferi Ziaaldini [*1]

1. Department of Physical Education and Sport Sciences, Ferdowsi University of Mashhad, Mashhad, Iran
2. Department of Physical Education and Sport Sciences, Toos Institute of Higher Education, Mashhad, Iran

Received: 20 October 2015
Accepted: 5 December 2015
Published online: 1 February 2016

***Corresponding author:**
Mohammad Mosaferi Ziaaldini. Department of Physical Education and Sport Sciences, Ferdowsi University of Mashhad, Mashhad, Iran

Phone: +985138833910
Fax: +985138829580

Email: mosaferi@um.ac.ir

Competing interests: The authors declare that no competing interests exist.

Citation: Mostafa Farkhani B, Javadi Kia M, Hejazi K, Fathi M, Attarzadeh Hosseini SR, Mosaferi Ziaaldini M. The recovery effect of cold water immersion and massage on the physical performance of young male soccer players. Rep Health Care 2016; 2 (1): 46- 54.

Abstract

Introduction: In recent years, reducing the time intercept between competitions and increasing the level and number of competitions, has made it one of the trainers' major concerns to adopt and employ a suitable recovery method to reduce fatigue and improve performance. The purpose of this study was to compare the effect of two recovery protocols of cold water immersion and massage on the performance of young male soccer players following an exhaustive exercise session.

Methods: Thirty young male soccer players were selected as statistical samples and divided into 3 groups of 10, including cold water immersion (CWI), massage (M) and passive recovery (P). 24 hours before and after an exhaustive test of simulated soccer match (90 minutes), tests of 20 m sprint, 40 m sprint, agility, vertical jump and RSA were taken from the subjects. To analyze the findings, dependent t-test, one-way ANOVA and Tukey's post hoc test were used ($p \leq 0.05$).

Results: There was no significant difference in the rate of variation in 20 m sprint and Sargent jump performances in the subjects of three groups ($P \leq 0.05$). Also, the agility of the CWI recovery group was significantly improved compared to the massage recovery group ($P = 0.003$). However, the repeat sprints ability in the recovery group of massage was significantly improved compared to the CWI recovery group ($p = 0.01$).

Conclusion: Using both recovery methods of cold water immersion and massage after an exhaustive exercise session has a positive effect on the performance of young male soccer players, and if the conditions are met, then both recovery methods will probably have positive effects.

Keywords: Recovery, Cold Water Immersion, Massage, Performance

Introduction

Due to the increase in the number of international competitions and domestic matches, soccer players are forced to carry out heavy match and exercises throughout the season (1). Choosing a recovery strategy to keep an athlete apt in the form of optimal physical fitness and also to reduce the risk of injury throughout the season can be an effective and determinant factor in player performance. Among the strategies used by coaches, one can mention stretching, sleeping, nutritional interventions, massage, cold water immersion, as well as contrasting bath (immersion in cold and warm water) (2). Today, cold water immersion has emerged as a popular way among various athletes. Although many different athletes use cold water immersion after exercises and competitions, the mechanisms that are effective in this phenomenon are not clear (3). Possible mechanisms may include a reduction in blood flow in the tissue that prevents inflammation and thus fatigue and pain (4). On the other hand, the researchers have suggested that immersion in cold water accelerates recovery

and exercise performance (2). Nonetheless, the limitations associated with the use of this method, including the availability of a pool at the training site or the competition location, as well as the contradictory results of the effectiveness of this technique, has made it doubtful to use this method. In this regard, Russell *et al.* (2009) reported the lack of impact of cold water immersion in 19 C^{o} for 10 minutes on repeated 20-meter sprint ability in soccer players (5). Ingram (2009) reported improvement in the best of times and all the time in repeated 20-meter sprint after water immersion in 10 C^{o} (6). Delextrat *et al.* examined the effects of intermittent cold water immersion on the repeat sprints ability in male professional basketball players. In their results, they stated that intermittent immersion in cold water does not have an effect on the recovery of sprint (7). Massage can be mentioned among other popular recovery strategies among athletes, but precise mechanisms are not well defined (7). One of the most important mechanisms of the effect of massage is the increase in the blood flow of tissue, which will increase the flow of oxygen and nutrients to the tissue and, as a result, will help improve recovery (8). However, most studies that have examined the effect of massage on recovery have used non-performance tests, so these results can not be generalized to the actual scene of the sports competition. In this regard, Kargarfard *et al.* examined the effect of 3 minutes of western massage on muscle soreness, vertical jump, and agility T-test in professional bodybuilders. They concluded that there was no significant difference between two groups of massage and control group 24 hours after massage (9). Delextrat *et al.,* in examining the effect of massage on fatigue, vertical jump performance and repeat sprints ability, showed that after-match, massage reduced fatigue feeling, but had no effect on vertical jumping and the repeat sprints ability (7). Considering the limitations of the studies and the inconsistencies in the results for each of them, as well as considering that most of the studies did not use performance tests, the aim of this study was to investigate the effect of two recovery strategies of cold water immersion (CWI) and massaging on the physical performance of young soccer players.

Methods

In this semi-experimental and applied study, 30 young male soccer players with a history of at least 2 years of regular soccer practice were selected as the statistical sample. All subjects were approved by a physician as being healthy and free of any diseases affecting the results of the study. A week before the beginning of the study, the subjects were called to the training site to measure anthropometric indices and learn about exhaustive training and performance tests. Information on general and anthropometric characteristics of the subjects is presented in Table 1. 24 hours after familiarization and anthropometric measurements, the subjects were called to the training site to determine the maximal oxygen uptake (VO_{2max}), and then based on VO_{2max}, the subjects were randomly assigned to three recovery groups with cold water immersion (CWI, N = 10), massage recovery (M, N = 10), and passive recovery as the control group (P, N = 10). 24 hours later, the subjects were again called to the training site to take performance tests and record the records. 48 hours after performance tests, an exhaustive exercise was performed and immediate recovery protocols were performed for each separate group. After 24 hours, performance tests were repeated as a post-test. An overview of the steps involved in research is shown in Figure 1. It should be noted that in order to reduce the interference from environmental stress by air temperature, for all groups, the exhaustive activity, the recovery method were done in the same hour of the day (1). To measure the maximal oxygen uptake, the shuttle run test was used. In order to run the test, first, two lines stretched out at a distance of 20 meters, and then one subject was placed

on one of them, and after placing the starter at a given interval, he reached the other line. This interval was characterized by a beep sound. After each step, the time interval was shortened by increasing the sprint of the movement. When the subject could not reach the line twice, the test was completed and the same step was recorded for the subject. Maximal oxygen uptake (Vo_{2max}) was obtained using the following formula (10).

Maximal Oxygen Uptake (ml / kg / min) = (maximum speed per hour / km × 6) - 4/24

The exhaustive exercise protocol in this project included a simulated soccer match, which comprised the Illinois ball agility test, walking, jogging and sprints. The implementation steps of this test are as follows: subjects first warmed up. Warming involves running (5 minutes), joint irritation (2 minutes), muscular nerve training (jumping forward and 10 m running speed) (2 minutes) jumping drill (3 jumps sequentially and 10 m running speed), then passive rest (2 Minutes) (7). It should be noted that after completing the warming steps and also during warming the subjects refused to perform static stretching. After completing the warm up, the subjects performed a soccer agility test. Each subject performed the test twice and the best record was recorded. The agility test used in this investigation was the Illinois ball agility. If the subject missed out testing the ball in the course of two rounds, he was allowed to perform the third test. Subjects then completed the LIST test. The test consisted of five sets of 15 minutes, the first three being separated by a three-minute break from the next two sets. In this test, every 15 minutes, the subjects exercised a soccer simulation including 3 repetitions of 20 m striding speed, 1 repetition of 20 m of running speed, 4 seconds of rest, 3 repetitions of 20 m of jugging at a speed of 55% of VO_{2max} and 3 repetitions of 20 meters running at a speed of 95% VO_{2max}). The subjects performed this for 15 minutes in succession (11). At the end of each 15 minutes, the subjects' beats were calculated and recorded. Also, at the end of every 15 minutes, the amount of subjects' pressure perception on the Borg's 10 score scale was asked and recorded. Subsequently, the subjects performed the soccer agility test again to determine the difference between the first and second tests of the exhaustive of the test. After doing the agility test, the subjects performed a running test to fatigue. This test was the way that the students ran the distance between the two 20-meter lines intermittently with 55% and 95% of VO_{2max} until they could not reach the line twice. The whole exhaustion exercise lasted roughly 90 minutes. The overview of the stages of exhaustion exercise is shown in Figure 2. During recovery period, massage recovery group received massage 5 minutes after completing the exhaustion exercise. The type and duration of massage were determined according to previous studies, so that short times were more effective in returning to the initial state. Also, further studies had taken advantage of western massage. Accordingly, each subject received a 6-minute western massage. Massage was performed by professional masseurs holding a degree from the Iranian Sports Medicine Federation and had at least two years of experience. The massage arrangement was as follows: the subject first lied prone on the massage bed and the masseur initially massaged the hamstring muscle group and then the gastrocnemius muscle group. The subject then leaned on the bed prostrate and the masseur massaged the quadriceps muscle mass. Massage muscle groups were: hamstring (2 minutes) gastrocnemius (2 minutes) quadriceps (2 minutes) (8). 5 minutes after the end of the exhaustion exercise, the recovery group with cold water immersion, being naked and wearing only one sports shorts were immersed up to the chest in the pool (Intex) in 11 to 15 degrees water, for 10 minutes. Subjects were asked to have the least possible movement within the water. In order to prevent the excessive increase in water temperature, ice pieces were added to the water pool to

maintain a constant temperature within the desired range (7). The water temperature was controlled by the waterproof thermometer at all times of recovery. The passive recovery group was considered as a control group in this study. 5 minutes after completing the exhaustion exercise, the passive recovery group performed 10 minutes static sedentary stretching exercises. The muscle groups of the stretching were Hamstring, gastrocnemius and quadriceps (8). In this study, performance tests were taken two times before and after the recovery protocols of the subjects including: 1- Sargent jump test 2- Illinois agility test for soccer, 3- 20 m speed test, 4- 40 m sprint test, and 5- repeat sprints ability (RSA) test. Sargent jump test was performed as the subject first stood beside the wall and then handed the ball to the highest point and the subject's touching point was recorded. The subject then touched the highest point by jumping up to 90 ° after bending his knees. The distance between the second and first points was recorded as the test record. Each subject performed the test three times and recorded the best record. The subject rested for two minutes between each run (12). In 20 meter and 40 meter sprint tests the subject stood behind the starting line, with a front leg (the dominant leg) and one back leg, and with the command of the starter, he traversed the path of 20 and 40 meters. Two referees calculated the time for the subject in order to increase the test's reliability at the end point (13). Repeat sprints ability (RSA) test included 15 paths of 40 meters that subjects should run at full speed. The subjects were resting for 30 seconds every 40 meters. After the end of the test, the reduced percentage in the score of the subject was calculated according to the following formula (13).

$$\mathbf{RSA_{Sdec}} = \left[\frac{S1+S2+S3+\cdots+Sfinal}{Sbest \times number\ of\ sprints} - 1\right] \times 100$$

It should be noted that in order to prevent the effect of fatigue on the test on the day of taking performance tests, first, power tests and then glycolytic tests of the subjects were taken. Also, in order to control the accuracy of the study, subjects were asked to avoid heavy physical activity 48 hours before taking performance tests prior to pretest and posttest. Also, in order to eliminate metabolic and nutritional interventions on recovery, in both the pretest and posttest, the subjects were asked to get 60% of their energy from carbohydrates two days before participating in the plan, and also write down their meals and make them available to the researcher (13). To analyze the findings, dependent t-test, one-way ANOVA and Tukey's post hoc test were used ($p \geq 0.05$).

Results

The demographic characteristics of the subjects are presented in Table 1. Also, the performance of the subjects in the Sargent jump test, the Illinois soccer agility test, the 20-meter sprint test, the 40-meter sprint test, and the repeat sprints ability test in three groups of research has been presented. The results of one-way ANOVA showed that there was no significant difference in the rate of changes in the performance of 20 m sprint in the subjects of three groups of research ($p = 0.16$). Also, the results of dependent t-test showed that there was no significant difference between the pre- and post-test levels of the performance test of 20 meters in CWI recovery group ($p = 0.83$) and massage group ($p = 0.42$). Therefore, both CWI recovery and massage techniques prevented the performance loss of subjects (Table 2). The results of one-way ANOVA showed that there was no significant difference in the rate of variation in 40 m sprint performance of the subjects in three groups of research ($p = 0.41$). Also, the results of t-test showed that there was no significant difference in the pre-test and post-test levels of 40 m performance in the massage group ($p = 0.50$). Therefore, the massage technique prevented the performance loss of the subjects. However, in the CWI recovery group, the 40-m performance in the post-test

was significantly lower than the pre-test (P = 0.001).

Also, there was no significant difference in the rate of variation of 40 m sprint performance in pre-test and post-test in the passive recovery group (p=0.25) (Table 2). The results of one-way ANOVA showed that there was a significant difference in the rate of variation in agility performance in the subjects in the three groups (p = 0.003), so that the results of Tukey's post hoc test showed that improvement of the performance of the subjects in the CWI recovery group in comparison with massage recovery group was significant (p = 0.003). Also, the results of t-test showed that in the CWI recovery group, agility performance in post-test was significantly increased compared to the pre-test (p = 0.007). However, in massage recovery group, agility performance in post-test was significantly decreased compared to the pre-test (p = 0.01). Also, there was no significant difference in the rate of variation in agility in the pre-test and post-test in the passive group (p = 0.38) (Table 2). The results of one-way ANOVA showed that there was no significant difference in the rate of variation in jump performance among subjects in three groups of research (p = 0.24). Also, the results of t-test showed no significant difference in pre-test and post-test Sargent jump in CWI recovery (p = 0.07), massage (p = 0.77) and passive recovery (p = 0.78) groups (Table 2). The results of one-way ANOVA showed that there was a significant difference in the rate of variation in the repeat sprints ability of the subjects in thee groups of research (p = 0.01), so that the results of Tukey's post hoc test showed that improvement of the performance of the subjects in the massage recovery group compared to the CWI recovery group was significant (p = 0.01). Also, the results of dependent t-test showed that there was no significant difference in the changes in the pre-test and post-test levels of the repeat sprints ability in the CWI recovery group (p = 0.62). Nonetheless, in the massage group (p = 0.02) and the passive recovery group (p = 0.01), the repeat sprints ability in the post-test significantly improved (Table 2).

Table 1. Demographic characteristics of subjects (mean ± standard deviation)

Group (N=10)	Vo_{2max} (ml/kg/min)	BMI (Kg/m^2)	Weight (Kg)	Height (cm)	Age (Year)
CWI	53.7±2.6	19.92±0.76	57.9±5.1	171.5±7.9	17.3±0.4
M	48.2±3.3	21.65±2.36	65.8±10.2	174.1±8	17.6±0.09
P	49.8±3/9	20.17±1.73	60.6±5.3	173.5±7.3	17.2±0.07

CWI: Cold Water Immersion, M: Massage, P: Passive

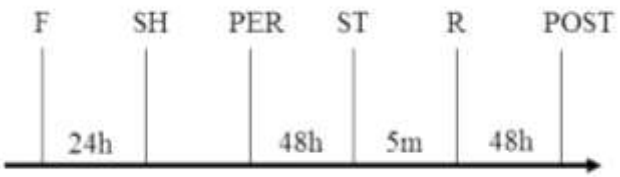

Figure 1. Schematic representation of the whole research plan

R: recovery, ST: stimulated soccer match test, SH: shuttle throttle test to estimate maximal oxygen uptake, F: familiarity, PRE: pre- test, POST: post- test, h: hour, m: min

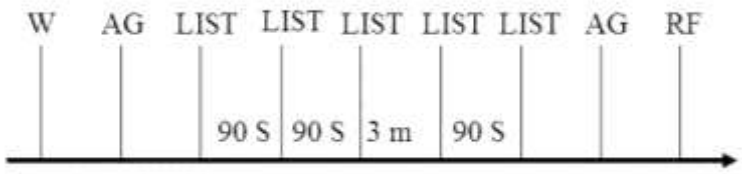

Figure 2. A general overview of the stages of simulated soccer match
RF: running to fatigue, AG: agility test, W: warm up, S: second, m: minute, LIST: loughborough intermittent shuttle test

Table 2. The results of paired sample t- test and one-way ANOVA test to compare intra-group and inter-group mean changes

Test	Group	Time	Mean ± SD	t	p	F	P
20m	CWI	Pre-test	3.31 ± 0.16	0.215	0.83	1.92	0.16
		Post-test	3.30 ± 0.15				
	M	Pre-test	3.37 ± 0.13	0.509	0.42		
		Post-test	3.46 ± 0.27				
	P	Pre-test	3.31 ± 0.17	-2.858	0.01		
		Post-test	3.53 ± 0.20				
40m	CWI	Pre-test	5.52 ± 0.22	-7.382	0.001	0.91	0.41
		Post-test	5.85 ± 0.21				
	M	Pre-test	5.68 ± 0.20	-0.702	0.50		
		Post-test	5.78 ± 0.38				
	P	Pre-test	5.82 ± 0.45	-1.216	0.25		
		Post-test	6.02 ± 0.18				
Ag	CWI	Pre-test	22.34 ± 1.28	3.510	0.007	7.29	0.003*
		Post-test	21.32 ± 1.60				
	M	Pre-test	22.37 ± 1.66	-3.216	0.01		
		Post-test	23.43 ± 2.07				
	P	Pre-test	21.64 ± 1.56	-0.917	0.38		
		Post-test	22.13 ± 2.48				
S	CWI	Pre-test	45.80 ± 5.73	-2.058	0.07	1.50	0.24
		Post-test	49.00 ± 6.18				
	M	Pre-test	44.40 ± 4.88	0.294	0.77		
		Post-test	44.20 ± 4.80				
	P	Pre-test	50.00 ± 6.58	283	0.78		
		Post-test	49.30 ± 4.55				
RSA	CWI	Pre-test	8.44 ± 2.83	0.509	0.62	4.90	0.01*
		Post-test	7.75 ± 2.46				
	M	Pre-test	10.38 ± 5.41	-2.600	0.02		
		Post-test	15.33 ± 7.68				
	P	Pre-test	9.34 ± 4.28	-3.155	0.01		
		Post-test	9.75 ± 4.41				

20m: 20-meter sprint test, 40m: 40-meter sprint test, Ag: Agility test, S: vertical jump, RSA: Repeat sprints ability. CWI: cold water immersion, M: massage, P: passive.* significant difference between CWI vs M.

Discussion

Results of this study revealed that recovery with the CWI prevented the loss in the performance of 20 m sprint, vertical jump and RSA following an exhaustion exercise. It also improved the performance of the subjects' agility; however, it did not affect a 40-meter sprint performance. In addition, massage recovery following an exhaustion exercise prevented the loss in the performance of 20 m sprint, 40 m sprint, vertical jump and RSA, but failed to affect agility performance of the subjects. Also, the results of the 20-m sprint test showed that there was no significant difference between the two groups of cold water immersion and massage in performance. Regarding the recovery effect on the performance of sprint, no study has yet examined the effect of the above recovery methods on the performance of a 20-m sprint test. However, Anderson *et al.* (2008) showed that without any recovery strategies in young female soccer players, recovery would be completed at speed running after 5 hours and the performance of athletes returns to normal levels (14). Concerning the precise and reasonable molecular and cellular mechanism in relation to the effect of cold water immersion, no accurate study has been done. However, in the present study, it seems that considering that a 40-meter sprint test compared to 20-meter sprint needs higher speed and endurance, most likely, CWI recovery subjects are less able to recover and maintain their speed than the massage group. In the present study, CWI recovery resulted in a significant improvement in agility, however, massage recovery resulted in a significant decrease in agility. Concerning the effect of massage on agility, the findings of this study are in line with the findings of the study by Kargarfard *et al.* (2016) (9). In this regard, Kargarfard *et al.* examined the effect of 3 minutes of western massage on muscle soreness, vertical jump, and T-test in professional bodybuilders. They concluded that there was no significant difference between two groups of massage and control group 24 hours after massage (9). The possible causes of loss of performance within 24 hours of massage can be seen in the post-activation potential of this recovery strategy (8). Also, considering that the test used in the present study is a simulated soccer agility test, skill level can be referred to as an interventional variable. The results of this study showed that in CWI recovery group, no significant changes were observed in the repeat sprints ability. The results of this study are consistent with the results of Russell *et al.* (2009). Russell reported a non-impact of immersion in 19-degree cold water for 10 minutes on repeating the 20-meter sprint in soccer players. In this regard, the results of the present study were consistent with the results of Delextrat *et al.* (2012) (7). Anna and colleagues in their study examined the impact of immersion in intermittent cold water on the repeat of sprints in male professional basketball players. In their results, they said that cold water immersion does not have an intermittent effect on speed recovery. However, the results of this study are inconsistent with the results of Ingram (2009). Ingram reported improvement at the best of times and all the time in repeating 20 meter sprints after immersion in 10 degree water (6). Possible reasons for the difference in the results of Ingram with the results of this study are the difference in the distance of the RSA test in Ingram study with the present study (40 meters versus 20 meters, respectively). The results of this study showed that CWI recovery and massage did not have a significant effect on the Sargent jump performance. Concerning cold water immersion, the results of this study are in line with the results of studies by Russell *et al.* (2009), Kinugasa et al (2009), and Montgomery *et al.* (2008) (5, 15, 16). In the study of Russell *et al.* (2009) as well as Kinugasa *et al.* (2009), as in the present study, a continuous immersion method in cold water had been used (10 minutes in water from 10 to 12 degrees, respectively) (5, 15). In contrast,

in the study by Montgomery *et al.* (2008) intermittent immersion method was used (1 minute immersion and 2 minutes rest for 5 sets and a total of 5 minutes immersion) (16). Considering the performance of Sargent jump, the findings of this study are inconsistent with the results of the research by Delextrat *et al.* (2012). Delextrat *et al.* (2012) used an intermittent method of immersion. Among the main reasons for these differences and the contradictory results of the impact of cold water immersion on vertical jump include water temperature, individual differences, and psychological problems (7). Positive mechanisms of cold water immersion can include reduced muscle blood flow, and hence, reducing inflammation and precluding muscle soreness. Another positive point in this case is to prevent the excessive temperature of the muscle due to immersion in cold water, which in turn prevents further inflammation (16). In this regard, regarding massage and its effect on vertical jump, the results of this study were inconsistent with the results of Kargarfard *et al.* (2016) (9). Among the causes of performance degradation in the study of Kargarfard *et al.* maybe longer massage time than the current study. In a study by Kargarfard *et al.,* subjects, two hours after completing the training, received massage for 30 minutes which may have led to an increased potential for post-activation of the massage. Serotonin secretion is also a major cause of exacerbation of the central fatigue and increases it (8).

Conclusion

The results of this study showed that both recovery methods of cold water immersion and massage after an exhaustion exercise session have a positive effect on the physical performance of young male soccer players, and if the conditions are met, then both recovery methods are likely to have positive effects.

Ethical issues

Not applicable.

Authors' contributions

All authors equally contributed to the writing and revision of this paper.

Acknowledgements

The authors of the present study wish to express their sincere gratitude to the subjects who sincerely cooperated in the implementation of the research.

References

1. De Nardi M, La Torre A, Barassi A, Ricci C, Banfi G. Effects of cold-water immersion and contrast-water therapy after training in young soccer players. J Sports Med Phys Fitness. 2011; 51 (4): 609- 615.
2. Ascensão A, Leite M, Rebelo AN, Magalhães S, Magalhães J. Effects of cold water immersion on the recovery of physical performance and muscle damage following a one-off soccer match. J Sports Sci. 2011; 29 (3): 217- 225.
3. Rowsell GJ, Coutts AJ, Reaburn P, Hill-Haas S. Effect of post-match cold-water immersion on subsequent match running performance in junior soccer players during tournament play. J Sports Sci. 2011; 29 (1): 1- 6.
4. Moreira A, Costa EC, Coutts AJ, Nakamura FY, Silva DA, Aoki MS. Cold water immersion did not accelerate recovery after a futsal match. Rev Bras Med Esporte. 2015; 21 (1): 40- 43.
5. Rowsell GJ, Coutts AJ, Reaburn P, Hill-Haas S. Effects of cold-water immersion on physical performance between successive matches in high-performance junior male soccer players. J Sports Sci. 2009; 27 (6): 565- 573.
6. Ingram J, Dawson B, Goodman C, Wallman K, Beilby J. Effect of water immersion methods on post-exercise recovery from simulated team sport

exercise. J Sci Med Sport. 2009; 12 (3): 417- 421.
7. Delextrat A, Calleja- González J, Hippocrate A, Clarke ND. Effects of sports massage and intermittent cold-water immersion on recovery from matches by basketball players. J Sports Sci. 2013; 31 (1): 11- 19.
8. Poppendieck W, Wegmann M, Ferrauti A, Kellmann M, Pfeiffer M, Meyer T. Massage and performance recovery: a meta-analytical review. Sports Med. 2016; 46 (2): 183- 204.
9. Kargarfard M, Lam ET, Shariat A, Shaw I, Shaw BS, Tamrin SB. Efficacy of massage on muscle soreness, perceived recovery, physiological restoration and physical performance in male bodybuilders. J Sports Sci. 2016; 34 (10): 959- 965.
10. Ramsbottom R, Brewer J, Williams C. A progressive shuttle run test to estimate maximal oxygen uptake. Br J Sports Med. 1988; 22 (4): 141- 144.
11. Goedecke JH, White NJ, Chicktay W, Mahomed H, Durandt J, Lambert MI. The effect of carbohydrate ingestion on performance during a simulated soccer match. Nutrients. 2013; 5 (12): 5193- 5204.
12. Markovic G, Dizdar D, Jukic I, Cardinale M. Reliability and factorial validity of squat and countermovement jump tests. J Strength Cond Res. 2004; 18 (3): 551- 555.
13. Iaia FM, Fiorenza M, Perri E, Alberti G, Millet GP, Bangsbo J. The effect of two speed endurance training regimes on performance of soccer players. PloS One. 2015; 10 (9): e0138096.
14. Andersson HM, Raastad T, Nilsson J, Paulsen G, Garthe I, Kadi F. Neuromuscular fatigue and recovery in elite female soccer: effects of active recovery. Med Sci Sports Exerc. 2008; 40 (2): 372- 380.
15. Kinugasa T, Kilding AE. A comparison of post-match recovery strategies in youth soccer players. J Strength Cond Res. 2009; 23 (5): 1402- 1407.
16. Montgomery PG, Pyne DB, Hopkins WG, Dorman JC, Cook K, Minahan CL. The effect of recovery strategies on physical performance and cumulative fatigue in competitive basketball. J Sports Sci. 2008; 26 (11): 1135- 1145.