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EFFECT OF COLD WATER İMMERSION ON PERFORMANCE

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Abstract:
This study was conducted to investigate the effect of cold water immersion on some performance parameters. The study consisted of 19 male badminton athletes, 10 of whom were experimental and 9 of whom were control groups. All athletes who participated in the study were given a pre-exercise agility test and a 30 m speed test. Afterwards, the muscle injury exercise protocol consisting of depth jumps was applied to the athletes and then, cold water immersion was applied to the test group for 10 minutes at 15°C. Field tests were repeated 24 hours after cold water immersion (24h). Athletes in the control group participated in all measurements except cold water immersion. Significant differences were found between control and experimental group at 24h 30 m and agility tests showed significant difference between experimental and control groups ($p < 0.05$). As a result, it was concluded that due to the shorter recovery times, the performance of athletes exposed cold water immersion is better.

Keywords: cold water immersion, performance

1. Introduction

With the developments in training science and the influence of technology, coaches and athletes increase the rate of recovery, maximize their performance improvement, and develop different methods to maintain improved performance throughout the season.

Training and competition sports cause strain on physiological systems. With some post-exercise practices, athletes recover physiologically and get ready for the next training (Ascensão et al. 2011). Athletes regard resting after a heavy exercise as a physiological and psychological need and they aim to get rid of muscular pain and loss of power as quickly as possible and to return the muscles and body to the pre-training position (Fox and Bowers 2011; Gulick et al., 1996). Taking these into account, there are some methods to recover more efficiently after training and competitions and to allow the organism to return to pre-training conditions. These methods include cold water immersion, cryotherapy, thermotherapy, non-steroidal anti-inflammatory drugs, nutrition and massage. These methods are used by athletes and coaches to increase the speed of recovery (Bompa and Haff, 2015). Cold water immersion, one of these methods, has frequently been used recently. Studies show that the water temperature can be between about 10°C and 15°C and the waiting time can be between 10 and 15 minutes for a good recovery in the cold water immersion method (Takeda et al., 2014; Bastian et al., 2011).

2. Materıals and Method

2.1. Research Group

20 male badminton players, who regularly trained, participated in this work. The athletes who did not train during the week prior to the start date of the study were divided into two groups, 10 athletes in the experimental group and 10 athletes in the control group, and the athlete groups were informed about the study.

2.2. Study design

The body composition of the athletes was measured the day before the measurements began. The athletes' body surface temperatures were measured under resting conditions on the day the measurements were to be made, and immediately after an appropriate warm-up, the athletes were subjected to the agility test (Illinois test) and the 30-m sprint test. After the tests, the athletes have been given a muscular damage exercise protocol. Immediately after the muscular damage exercise protocol was applied, cold water immersion was applied to the experimental group at 15°C for 10 minutes. Meanwhile, the athletes in the control group were kept in sitting position at 25°C ambient temperature. Afterwards, the athletes were told to rest passively for 24 hours and immediately after this rest, field tests were applied again to the experimental and control groups.

2.3. Muscle damage exercise protocol

The exercise protocol consisted of 5 sets of 20 repetitions of depth jumps from a height of 60 cm. Jumps were performed with 10-second intervals, and 2-minute rests were given between the sets. When the athletes jumping from the height of 60cm stepped on the floor, they were asked to jump as far as possible from a 90° flexion. (Goodall and Howatson, 2008; Kirby et al. 2012)

2.4. Cold Water Immersion

After the muscle damage protocol was applied, the experiment group was held in sitting position in the water at 15^0C with the neck and shoulders out for 10 minutes. To keep the water temperature at 15^0C, the water temperature was regularly monitored with a precision thermometer. When the water temperature rose, the ice particles were added to the water and the water temperature was kept under control (Takeda et al., 2014).

2.5. Data Collection

2.5.1. Body composition

One day before the measurements, the size and weight of the athletes were measured with a Seca brand height and weight measuring tool and Bio-electrical Impedance (Tanita Body Fat Analyzer, Model TBF 300) was used to determine their body fat percentages.

3.5.2. Body Temperature Measurement

Both the test and control groups' body surface temperature was measured at regular intervals with the contactless thermometer (F.Bosch Fb-Scan).

A. Illinois test

The Illinois test was applied by placing four cones in a rectangular area of 5m in width and 10m in length Return cones were placed 10m opposite to the starting and ending cones. The distance between the starting and ending cones is 5 m. The station was made by placing four cones at 3.3m intervals at 2.5m, which is the centre of the starting and ending cones. The athletes exit with the command from the start cone, turn from the return cone, make a slalom to the cones placed in the centre, then make a straight run and turn from the return cone opposite the finishing cone and they complete the station at the finishing cone (Michael, and Robert, 2009).

B. 30 m Sprint test

In this test, the athletes ran 30 metres 3 times with full rest between them and the best score was recorded (Michael, and Robert, 2009). The sprints were performed on a 30-meter tartan track and the "Power 2000 Newtest" brand photocell was used.

2.6. Statistical analysis

The pre-test and post-test analyses of the experimental and control groups and the comparison between the experimental and control groups were performed by independent t test. Arithmetic mean and standard deviation values of the groups were also taken. The significance level was taken as p <0.05.

3. Fındıngs

Table 1: Descriptive statistics of the control and experimental groups

Group		N	Minimum	Maximum	Mean	Standard Deviation
Control	Age (year)	9	21	27	21.4	2.18
	Height (cm)	9	165.4	184.6	171.50	4.43
	Weight (Kg)	9	49.5	82.3	66.7	9.74
	BMI(kg/height$^{2)}$	9	17.6	26.4	20,76	2.09
	BFI (%)	9	3.7	21.6	13.61	5.71
Experimental	Age (year)	10	21	26	22.6	3.21
	Height (cm)	10	164	179	174.3	4.07
	Weight (Kg)	10	60.4	69.5	63.44	1.97
	BMI(kg/height$^{2)}$	10	17.4	21.2	20.11	1.36
	BFI (%)	10	6.9	18.2	12.24	2.41

* BMI: Body mass index ** BFI: Body Fat Index

When the arithmetical mean and standard deviation values for the anthropometric values of the control group participating in the study are calculated according to the schedule, the age was determined as 21.4±2.18 years, height 17.50±4.43 cm, body weight 66.7±9.74 kg, BMI 20.76±2.09 kg/height^2 and BFI 13.61±5.71. For the experimental group, age was determined as 22.6 ± 3.21 years, height 174.3 ± 4.07 cm, 63.44 ± 1.97 kg, BMI 20.11 ± 1.36 kg/height^2 and the BFI 12.24 ± 2.41.

Table 2: Comparisons of Control and Experimental Groups' 30 meter and agility tests

	Group	N	Arithmetic Mean	Standard Deviation	t	p
B.E - 30 m	Control	9	4.26	0.16	0.312	> 0.05
	Experimental	10	4.24	0.13		
24h - 30 m	Control	9	4.72	0.19	**2.307**	***<0.05**
	Experimental	10	4.51	0.21		
B-E. Agility	Control	9	15.60	0.41	0.677	> 0.05
	Experimental	10	15.48	0.39		
24h - Agility	Control	9	16.12	0.41	**2.319**	***<0.05**
	Experimental	10	15.63	0.52		

B.E: Before Exercise, 24h: 24 hours After Cold Water Immersion

No significant differences were found in control and experimental groups' pre-exercise 30 m and agility tests (p > 0.05). Significant differences were found in control and experimental groups' post-exercise 30 m and agility tests (p<0.05).

Table 3: Pre-test and 24h comparisons of control group's 30 meter and agility tests

Control Group	N	Arithmetic mean	Standard Deviation	t	p
B.E - 30 m	9	4.26	0.16	**-5.172**	****<0.01**
24h - 30 m	9	4.72	0.19		
B.E - Agility	9	15.60	0.41	**-4.768**	****<0.01**
24h - Agility	9	16.12	0.41		

B.E: Before Exercise, 24h: 24 hours After Cold Water Immersion

Significant difference at p <0.01 level was found for 30-meter values of pre- and post-exercise. A significant difference at p <0.01 level was found for the agility values of pre-exercise and post- exercise.

Table 4: Pre-test and 24h comparisons of experimental group's 30 meter and agility test

Experimental Group	N	Arithmetic mean	Standard Deviation	t	p
B.E - 30 m	10	4.24	0.13	**-5.544**	*****<0.001**
24h - 30 m	10	4.51	0.21		
B.E - Agility	10	15.48	0.39	-1.740	> 0.05
24h - Agility	10	15.63	0.52		

B.E: Before Exercise, 24h: 24 hours After Cold Water Immersion

A significant difference at p <0.001 level was found for the 30 meter values of pre- and post- exercise. There was no significant difference in pre- exercise and post- exercise agility values (p> 0.05).

4. Dıscussıon

When the studies on muscular damage were examined, it was determined that muscular damage occurred in the athletes after various exercising methods applied. It has been described in the literature that one of the most effective types of training that cause muscular damage from these training methods is eccentric muscular contractions (Proske and Allen, 2005; Banfi et al., 2010; Hikida et al., 1983; Warhol et al.1985; Lauritzen et al., 2009; Warren et al., 2001; Corona et al., 2010; Burt and Twist, 2011; Philippou et al., 2009; Ascensão et al., 2008).

The depth jump exercise protocol used in this study was also used by many researchers. After this type of protocol applied, the researchers examined the levels of serum CK, AST and LDH and obtained the result that muscular damage had happened in the athletes.

Statistical analyses revealed significant differences at the p <0,05 level in the post exercise 30-meter speed and agility tests of the control and experimental groups in this study which was conducted to investigate the effect of cold water immersion applied after muscular damage occurring due to exercise on the performance.

It is known that the cold water immersion applied immediately after exercise inhibits the pain in the muscles and reduces the muscular stiffness and the loss of ability in the joints occurring due to exercise, thus affecting the performance positively (Bleakly, 2012). It was observed that cold water immersion for 10 minutes at 10°C applied to footballers after the match is effective in accelerating adaptation and regeneration after exercise (Ascensão et al., 2011).

Studies have shown that cold water immersion reduces muscular inflammation and alleviates delayed muscular pain (DOMS) and contributes to increasing muscular function (Cheung et al., 2003; Barnett, 2006; Versey et al., 2013; Yates et al., 2003). It is also thought that cold water application after exercise effectively treats and prevents muscular damage, thus enhancing performance by positively affecting fatigue after exercise (Glasgow et al., 2014; Bleakly, 2012). A study conducted at different ambient temperatures showed that athletes are more successful in the cold environment than in the hot environment in agility and speed parameters </ex> (Çakır et al., 2014).

The study by Bleakly et al. (2012) showed that cold water immersion inhibits muscular damage after training and competitions and treats muscular injuries and has a positive effect in reducing fatigue (Bleakly, 2012). Another study statistically determined that after the cold water immersion applied to the rugby players, the experimental group was more successful than the control group at 50 m sprint (Takeda 2014).

5. Conclusıon

Literature reviews determined that skeletal muscular damage was apparent in the athletes after high intensity exercise and competitions. In this study, cold water immersion was applied to the athletes in order to reduce the skeletal muscular damage after such exercises as soon as possible and in order for the athletes to recover more efficiently and the data obtained showed that cold water immersion has a positive effect on muscular damage, accelerates recovery and affects the performance positively.

References

1. Ascensão, A., Leite, M., Rebelo, A. N., Magalhäes, S., & Magalhäes, J. (2011). Effects of cold water immersion on the recovery of physical performance and muscle damage following a one-off soccer match. *Journal of sports sciences*, *29*(3), 217-225.
2. Fox, EL., Bowers, RW., Foss, ML. (2011). *Beden Eğitimi ve Sporun Fizyolojik Temelleri.* 3. Baskı. Ankara, Spor Yayınevi ve Kitabevi. 31–49.
3. Gulick, D. T., Kimura, I. F., Sitler, M., Paolone, A., & Kelly IV, J. D. (1996). Various treatment techniques on signs and symptoms of delayed onset muscle soreness. *Journal of athletic training*, *31*(2), 145.
4. Bompa, TO., Haff, GG. (2015). *Dönemleme: Antrenman Kuramı ve Yöntemi.* Çeviri: Tanju Bağırgan., Spor Yayınevi ve Kitapevi. Ankara.
5. Goodall, S., & Howatson, G. (2008). The effects of multiple cold water immersions on indices of muscle damage. *J Sports Sci Med*, *7*(2), 235-41.
6. Kirby, T. J., Triplett, N. T., Haines, T. L., Skinner, J. W., Fairbrother, K. R., & McBride, J. M. (2012). Effect of leucine supplementation on indices of muscle damage following drop jumps and resistance exercise. *Amino acids*, *42*(5), 1987-1996.
7. Takeda, M., Sato, T., Hasegawa, T., Shintaku, H., Kato, H., Yamaguchi, Y., & Radak, Z. (2014). The effects of cold water immersion after rugby training on muscle power and biochemical markers. *Journal of sports science & medicine*, *13*(3), 616.
8. Proske, U., & Allen, T. J. (2005). Damage to skeletal muscle from eccentric exercise. *Exercise and sport sciences reviews*, *33*(2), 98-104.
9. Banfi, G., Lombardi, G., Colombini, A., & Melegati, G. (2010). Whole-body cryotherapy in athletes. *Sports medicine*, *40*(6), 509-517.
10. Hikida, R. S., Staron, R. S., Hagerman, F. C., Sherman, W. M., & Costill, D. L. (1983). Muscle fiber necrosis associated with human marathon runners. *Journal of the neurological sciences*, *59*(2), 185-203.
11. Warhol, M. J., Siegel, A. J., Evans, W. J., & Silverman, L. M. (1985). Skeletal muscle injury and repair in marathon runners after competition. *The American journal of pathology*, *118*(2), 331.
12. Lauritzen, F., Paulsen, G., Raastad, T., Bergersen, L. H., & Owe, S. G. (2009). Gross ultrastructural changes and necrotic fiber segments in elbow flexor muscles after maximal voluntary eccentric action in humans. *Journal of Applied Physiology*, *107*(6), 1923-1934.

13. Warren, G. L., Ingalls, C. P., Lowe, D. A., & Armstrong, R. B. (2001). Excitation-contraction uncoupling: major role in contraction-induced muscle injury. *Exercise and sport sciences reviews*, *29*(2), 82-87.
14. Corona, B. T., Balog, E. M., Doyle, J. A., Rupp, J. C., Luke, R. C., & Ingalls, C. P. (2010). Junctophilin damage contributes to early strength deficits and EC coupling failure after eccentric contractions. *American Journal of Physiology-Cell Physiology*, *298*(2), C365-C376.
15. Burt, D. G., & Twist, C. (2011). The effects of exercise-induced muscle damage on cycling time-trial performance. *The Journal of Strength & Conditioning Research*, *25*(8), 2185-2192.
16. Philippou, A., Maridaki, M., Bogdanis, G., Halapas, A., & Koutsilieris, M. (2009). Changes in the mechanical properties of human quadriceps muscle after eccentric exercise. *in vivo*, *23*(5), 859-865.
17. Ascensão, A., Rebelo, A., Oliveira, E., Marques, F., Pereira, L., & Magalhães, J. (2008). Biochemical impact of a soccer match—analysis of oxidative stress and muscle damage markers throughout recovery. *Clinical biochemistry*, *41*(10), 841-851.
18. Bleakley, C., McDonough, S., Gardner, E., Baxter, D. G., Hopkins, T. J., Davison, G. W., & Costa, M. T. (2012). Cold-water immersion (cryotherapy) for preventing and treating muscle soreness after exercise. *Sao Paulo Medical Journal*, *130*(5), 348-348.
19. Cheung, K., Hume, P. A., & Maxwell, L. (2003). Delayed onset muscle soreness. *Sports Medicine*, *33*(2), 145-164.
20. Barnett, A. (2006). Using recovery modalities between training sessions in elite athletes. *Sports medicine*, *36*(9), 781-796.
21. Swenson, C., Swärd, L., & Karlsson, J. (1996). Cryotherapy in sports medicine. *Scandinavian journal of medicine & science in sports*, *6*(4), 193-200.
22. Yanagisawa, O., Niitsu, M., Yoshioka, H., Goto, K., Kudo, H., & Itai, Y. (2003). The use of magnetic resonance imaging to evaluate the effects of cooling on skeletal muscle after strenuous exercise. *European journal of applied physiology*, *89*(1), 53-62.
23. Michael, P.R., & Robert, C.M., (2009). Functional testing in human performance. *Human kinetics*.
24. Glasgow, P. D., Ferris, R., & Bleakley, C. M. (2014). Cold water immersion in the management of delayed-onset muscle soreness: Is dose important? A randomised controlled trial. *Physical therapy in sport*, *15*(4), 228-233.
25. Bastian, B., Jetten, J., & Fasoli, F. (2011). Cleansing the soul by hurting the flesh: The guilt-reducing effect of pain. *Psychological Science*, *22*(3), 334

26. Çakir, E., Yüksek, S., Asma, B., & Arslanoglu, E. (2016). Effects of Different Environment Temperatures on Some Motor Characteristics and Muscle Strength. *International Journal of Environmental and Science Education*, *11*(10), 3985-3993.