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. Materials 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°C with the neck and shoulders out for 10 minutes. To keep the water temperature at 15°C, 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.

2.5.2. 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. Findings

Table 1: Descriptive statistics of the control and experimental groups

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age (year)</td>
<td>9</td>
<td>21</td>
<td>27</td>
<td>21.4</td>
<td>2.18</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>9</td>
<td>165.4</td>
<td>184.6</td>
<td>171.50</td>
<td>4.43</td>
</tr>
<tr>
<td>Weight (Kg)</td>
<td>9</td>
<td>49.5</td>
<td>82.3</td>
<td>66.7</td>
<td>9.74</td>
</tr>
<tr>
<td>BMI(kg/height(^2))</td>
<td>9</td>
<td>17.6</td>
<td>26.4</td>
<td>20.76</td>
<td>2.09</td>
</tr>
<tr>
<td>BFI (%)</td>
<td>9</td>
<td>3.7</td>
<td>21.6</td>
<td>13.61</td>
<td>5.71</td>
</tr>
<tr>
<td>Experimental</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age (year)</td>
<td>10</td>
<td>21</td>
<td>26</td>
<td>22.6</td>
<td>3.21</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>10</td>
<td>164</td>
<td>179</td>
<td>174.3</td>
<td>4.07</td>
</tr>
<tr>
<td>Weight (Kg)</td>
<td>10</td>
<td>60.4</td>
<td>69.5</td>
<td>63.44</td>
<td>1.97</td>
</tr>
<tr>
<td>BMI(kg/height(^2))</td>
<td>10</td>
<td>17.4</td>
<td>21.2</td>
<td>20.11</td>
<td>1.36</td>
</tr>
<tr>
<td>BFI (%)</td>
<td>10</td>
<td>6.9</td>
<td>18.2</td>
<td>12.24</td>
<td>2.41</td>
</tr>
</tbody>
</table>

* 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

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

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

<table>
<thead>
<tr>
<th>Control Group</th>
<th>N</th>
<th>Arithmetic mean</th>
<th>Standard Deviation</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>B.E - 30 m</td>
<td>9</td>
<td>4.26</td>
<td>0.16</td>
<td>-5.172</td>
<td>**&lt;0.01</td>
</tr>
<tr>
<td>24h - 30 m</td>
<td>9</td>
<td>4.72</td>
<td>0.19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B.E - Agility</td>
<td>9</td>
<td>15.60</td>
<td>0.41</td>
<td>-4.768</td>
<td>**&lt;0.01</td>
</tr>
<tr>
<td>24h - Agility</td>
<td>9</td>
<td>16.12</td>
<td>0.41</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Experimental Group</th>
<th>N</th>
<th>Arithmetic mean</th>
<th>Standard Deviation</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>B.E - 30 m</td>
<td>10</td>
<td>4.24</td>
<td>0.13</td>
<td>-5.544</td>
<td>***&lt;0.001</td>
</tr>
<tr>
<td>24h - 30 m</td>
<td>10</td>
<td>4.51</td>
<td>0.21</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B.E - Agility</td>
<td>10</td>
<td>15.48</td>
<td>0.39</td>
<td>-1.740</td>
<td>&gt; 0.05</td>
</tr>
<tr>
<td>24h - Agility</td>
<td>10</td>
<td>15.63</td>
<td>0.52</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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. Discussion**

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 (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. Conclusion

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


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