ABSTRACT

The aim of this study was to investigate the effect of active and passive warm-up on anaerobic power of athletes. Male athletes (n=24) who participated in individual and team sports, participated in this study. Age, height, weight, upper and lower extremity anaerobic power measures were applied. Three different warm-up trials that were non warm-up (control), passive warm-up and active warm-up were applied on athletes. Between trials, 24-hour resting was given. For anaerobic power measures, Wingate test protocol for upper and lower extremities was applied. For lower extremity Monark 894E and for upper extremity Monark 891E bicycle ergometers were used. Repeated measures one way ANOVA test and Post-Hoc LSD correction were used for between warn-up trials analysis. According to obtained data, in all upper extremity anaerobic power parameters, statistically significant difference was determined between active warm-up trial to control trial (p<0.05). In all lower extremity

Key Words: Anaerobic power, Warm up, Massage, Athlete, Wingate test

* This article is based on the MSc thesis of Mustafa Özcan with the same title.
anaerobic power parameters, statistically significant difference was determined between active warm-up and control trial (p<0.05). As a conclusion, it could be said that active warm-up protocol has positive effects on anaerobic power compared to other warm-up protocols.

INTRODUCTION

Warm-up exercises are exercises that the organism gets ready physically and psychologically for the exercises to be done (Grosser, 1991). Warm-up is described as getting ready the muscles for performance movements (Zieschang, 1978). It is stated that warm-up increases physiological muscle temperature and muscle blood flow, improves the ability to control muscle stiffness and increases neurological functions (Geiss, 1984). In addition, it gives rise to regulation of blood flow by increasing heart beat numbers, respiration frequency and depth, energy and oxygen consumption physiologically in the athletes and increases movement scope by increasing the muscle viscosity. Warm-up movements are important for muscles to reach an upper level during training and competition (Magnusson et al, 2000).

Passive warm-ups are massages that are applied to certain areas of the organism. Massage is done by rhythmic hand movements on the soft tissues of the body. Massage manipulations have been used with the purpose of preparation for warm-up, relaxation and competition before training and competition that affects athletes’ physiological and anatomical development positively (Stamfored, 1985). Massage with its physiological psychological effects increases self-confidence in athletes and helps them perform better (Shelloek and Prentice, 1985).

This study has been done to examine whether active and passive warm-ups have effects on anaerobic power in athletes who deals with individual and team sports. It is thought that the results of our study will be important as it reveals the level of active and passive warm-up effects on anaerobic power.

METHODS

Subjects

24 healthy male students between 18-30 age average, who study in Gaziantep University, School of Physical Education and Sports, who deal with individual and team sports and participated national level competitions, participated the study voluntarily.
Experimental design

This study has been designed with cross subject design. Test to be applied to the subjects and the warm-up types was introduced a day before the first experiment. 3 applications have been applied to the subjects. In the first application (C) anaerobic power test have been applied to the subjects without any heating. In the second application (AW) anaerobic power test have been applied to the subjects with active heating. In the third application (PW) anaerobic power test have been applied to the subjects with passive (massage) heating. Written voluntary consent document that shows that the participants participated voluntarily have been obtained. Necessary permits for our study have been received from Gaziantep University Clinical Researches Ethics Board.

Protocols

Active warm-up (AW): Running, jumping, stretching, gymnastics and dumbbell exercises have been applied to subjects for 10 minutes.

Passive warm-up (PW): 10-minute massage has been applied with heater pomades by masseurs to the subjects.

Upper Extremity Wingate Anaerobic Power Test (WAnT): 5% of the body weight of the subjects has been loaded on the scale of the hand biking. When the subject is ready, loaded scale is dropped by pressing the button and from this moment hand pedals have been cycled with the peak effort for 30 seconds. At the end of 30 seconds anaerobic power has been recorded in terms of Watt.

Lower Extremity Wingate Anaerobic Power Test (WAnT): 7.5% of the body weight of the subjects has been loaded on the scale of the bike. When the subject is ready, loaded scale is dropped by pressing the button and from this moment subjects have cycled the pedals with the peak effort for 30 seconds. At the end of 30 seconds anaerobic power has been recorded in terms of Watt.
Statistical methods: In the statistical analysis of obtained data, SPSS 22.0 package program have been used. Data have been presented as arithmetic mean, standard deviation, minimum and maximum values. LSD correction test has been used to determine between which applications one-way variance analysis and differences occur in repeated measurements for the analysis of differences between lower extremity and upper extremity anaerobic power parameters, passive warm-up and active warm-up applications. Statistical results have been evaluated in p<0.05 significance level.

RESULTS

Table 2
Upper extremity Wingate test results of the participants (N=24)

<table>
<thead>
<tr>
<th></th>
<th>C</th>
<th>PW</th>
<th>AW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak Power</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean ± SD (W)</td>
<td>696.16 ± 200.42</td>
<td>711.68 ± 191.87</td>
<td>740.40 ± 214.46</td>
</tr>
<tr>
<td>Percent difference</td>
<td>2.23</td>
<td>6.35</td>
<td></td>
</tr>
<tr>
<td>Mean ± SD (W/kg)</td>
<td>9.92 ± 3.01</td>
<td>10.18 ± 3.11</td>
<td>10.54 ± 3.25</td>
</tr>
<tr>
<td>Percent difference</td>
<td>2.62</td>
<td>6.25</td>
<td></td>
</tr>
<tr>
<td>Mean Power</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean ± SD (W)</td>
<td>308.44 ± 47.48</td>
<td>313.49 ± 48.22</td>
<td>314.20 ± 53.29</td>
</tr>
<tr>
<td>Percent difference</td>
<td>1.64</td>
<td>1.87</td>
<td></td>
</tr>
<tr>
<td>Mean ± SD (W/kg)</td>
<td>4.37 ± 0.61</td>
<td>4.43 ± 0.71</td>
<td>4.45 ± 0.63</td>
</tr>
<tr>
<td>Percent difference</td>
<td>1.37</td>
<td>1.83</td>
<td></td>
</tr>
</tbody>
</table>

C, PW and AW upper extremity anaerobic parameters of the participants are presented in Table 2. A significant difference has been found in the peak power and mean power as a result of one-way variance analysis in repeated measurements for upper extremity (p<0.05). A significant difference has been found in the AW and C applications according to post-hoc test results that were done to determine between which applications the significant difference occurs.
Lower extremity anaerobic parameters measured at C, PW and AW have been presented in Table 3. A significant difference has been found in the peak power and mean power as a result of one-way variance analysis in repeated measurements for lower extremity (p<0.05).

![Percent difference between trials](image)

**Table 3**

*Lower Extremity Wingate test results of the participants (N=24)*

<table>
<thead>
<tr>
<th></th>
<th>C</th>
<th>PW</th>
<th>AW</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Peak Power</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean ± SD (W)</td>
<td>664.58 ± 99.99</td>
<td>702.61 ± 128.97†</td>
<td>746.04 ± 141.82 * †</td>
</tr>
<tr>
<td>Percent difference</td>
<td>5.72</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Mean ± SD (W/kg)</td>
<td>9.47 ± 1.22</td>
<td>9.92 ± 1.55‡</td>
<td>10.61 ± 1.55 * †</td>
</tr>
<tr>
<td>Percent difference</td>
<td>4.75</td>
<td>12.04</td>
<td></td>
</tr>
<tr>
<td><strong>Mean Power</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean ± SD (W)</td>
<td>454.10 ± 60.95</td>
<td>489.30 ± 56.14‡</td>
<td>501.99 ± 66.86 * †</td>
</tr>
<tr>
<td>Percent difference</td>
<td>7.75</td>
<td>10.55</td>
<td></td>
</tr>
<tr>
<td>Mean ± SD (W/kg)</td>
<td>6.41 ± 0.64</td>
<td>92 ± 0.70‡</td>
<td>7.14 ± 0.58 * †</td>
</tr>
<tr>
<td>Percent difference</td>
<td>7.96</td>
<td>11.39</td>
<td></td>
</tr>
</tbody>
</table>

C= Control, PW= Passive warm-up, AW= Active warm-up, SD= Standard Deviation, W= Watt

*Significance between AW and C
† Significance between AW and PW
‡ Significance between PW and C
DISCUSSION AND CONCLUSION

In our study, it is observed that active warm-up is effective on upper extremity anaerobic power values. For lower extremity, it is determined that active warm-up is more effective than the two other applications in peak power value, and in the mean power value, besides the same result, it is determined that passive warm-up is significantly different than control application.

Bishop et al. (2003), have obtained higher results according to non-stop warm-up (601 W) in the peak power parameter after intermittent warm-up (629 W). Gelen (2010) has stated that dynamic warm-up increases performance in short-term activities (jumping 8% and 7.66%). Jaggers et al. (2008), have found that warm-up increases vertical jump distance (+4.1 cm), strength (+0.9%) and power (+1.1 W/kg) in short-term activities. Sekir et al. (2009) have found that 6-minute warm-up exercise increases power in various muscle groups. Holt and Lambourne (2008), in their study on different warm-up protocols, have reported that short-term explosive activity increases after warm-up (23.6%). Clark et al. (2006) have observed that warm-up increases vertical jump performance (8.6%). In a similar study Cè et al. (2008) have stated that warm-up has positive effects on explosive power requiring activities.

There are many studies available on positive effects of warm-up on short term performance (Dolan et al., 1985; Grodjinovsky ve Magel, 1970; McKenna et al., 1987; Pacheco, 1957; Thompson, 1958). Increasing muscle temperature along with the warm-up has a potential to affect short-term performance (Bishop, 2003a; 2003b; Özdal, 2016). Among these causes, reduction of joint stiffness (Wright and Johns, 1961), increasing nerve conduction speed (Karvonen and Lemon, 1992), changing power-acceleration relation (Ranatunga et al., 1987), and increasing glycolysis/phosphate devastation (Febbraio et al., 1996) can be shown. Also, the links between actin and myosin filaments in the muscle break with the warm-up and reduce the muscle stiffness thus affect the performance (Proske et al, 1993).

Occurrence of the physiological responses of the kind described above to affect anaerobic power depends on the warm-up duration and severity. If the warm-up is short or long, there is no effect on anaerobic performance. The reason for this is that physiological reactions do not occur when it is short-termed and that the energy stores to support energy production drain away when it is long termed (Bishop, 2003a). Supportively, there are many scientific studies that warm-up does not affect anaerobic performance (Pyke, 1968; Sergeant et al., 1987; Hawley et al., 1989).

Faigenbaum et al. have examined the acute effects of different warm-up applications on anaerobic performances and concluded that static stretching and dynamic warm-up applications combined with dynamic warm-up increases the an-
aerobic power values on vertical jump and thus affect the performance positively (Faigenbaum et al., 2006).

Fletcher and Jones have concluded that static stretching application in the scope of warm-up reduces the short term running performance and active dynamic stretching application increases the 20 meter running performance (Fletcher and Jones, 2004).

Little and Williams have done vertical jump and sprint measurements of 18 professional football players after different warm-up applications that consists of static stretching, dynamic stretching and stretching exercises and concluded that dynamic stretching exercise is an important component in pre-warm-up and besides dynamic stretching exercise applied in the warm-up increases the vertical jump and sprint performances (Little and Williams, 2006).

In the study of Faigenbaum et al. named acute effect of different warm-up types of performance; significant differences have been found for the benefit of dynamic exercise group and dynamic exercise with jump group according to static stretching exercise group (Faigenbaum et al., 2005).

In a study done by Birukov and Karakhmaleva, they have concluded that pre-training passive (massage) warm-ups positively affect the anaerobic performances (Birukov and Karakhmaleva, 1987).

It is thought that blood flow to the muscle tissue, muscle temperature, muscle elasticity and spasm potential of the muscle increase with the active warm-up and thus anaerobic performance is affected positively. It can be said that the same effect is also seen with the passive (massage) warm-up even though it is superficial. As a result, it can be said that active warm-up affects anaerobic power performance positively, besides passive (massage) warm-up affects anaerobic performance positively even though it is not as much as active warm-up.

REFERENCES


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