Impact of Resistance Exercise on Experimental Pain Perception and Perceived Exertion, in the Trained Athletes Exercising in a Hot Climate

S. Lotfi, A. Jaziz, I. Zerdani and A. Tazi

Abstract: The aim of this research is investigating the effect of resistance exercise on the level of perceived pain caused by the experimental thermal heat. 11 athletes took part voluntarily in this research, aged 23.02 ±0.7 years, were assessed at rest (baseline levels) and after resistance exercise (accomplished in a hot climate 30.7°C) on duration of the hand immersed in hot water, physical fatigue, pain perception level, using the Verbal Analogue Scale (VAS) and Borg's RPE scale. Comparing to baseline levels, the values immersion time (36.05 ±5.15 vs 12.78 ±3.87) increase, and pain perception level (5.43 ±1.90 vs 8.86 ±1.46) decreased significantly (p<0.028, p<0.041) after the exercise. We also identified, a significantly negative high correlation (r = 0.846, p>0.008,) between the run performance (In time) and Borg RPE value and a significant correlation (r = 0.516, p<0.044) between pain perception level and the difficulty of perceived exertion. The resistance exercise performed in warm climate increases the sensitivity of pain physically perceived and felt. The body uses its own strategies to extend the suffering induced by resistance exercise to hot external stimuli.

Key words: Resistance exercise - Experimental pain - Perceived exertion - Hot climate

INTRODUCTION

Pain is a common human process that allows our body to feel our own somatic critical condition. The International Association for the Study of Pain [1] defines pain as an unpleasant sensory and emotional experience associated with tissue damage, real or virtual or described in terms of such damage. The pain goes beyond a disorder or malfunction of the physical kind, but reaches a combination of cognitive psychological, environmental and social factors [2]. We can differentiate between two types of pain: acute, when it comes to feeling very intense and brutal and when it comes to chronic pain that develops over time (Between three and six months) and disrupts the welfare of the human body in unbearable way. Indeed, the perception of pain requires highly developed structures of the central nervous system [3]. Moreover, these structures can be combined together to respond to the sensation of the pain experience. Meanwhile, the affective-emotional factor appears to explain the emotional expression and affective unique to this experiment [4]. In practice, this concept is widespread.

A systematic literature review on the effects of exercise has shown that all 3 types of exercise (Isometric, dynamic resistance, aerobic) reduce perception of experimentally induced pain in healthy participants, with effects ranging from small to large depending on pain induction method and exercise protocol [5]. Another meta-analysis has revealed that athletes possessed overall higher pain tolerance compared to normally active controls [6]. However, the available conclusions of research on pain perception and exercise were rather sparse and less uniform. However, Miles et al. [7] have shown that the intense athletic training may lead to the appearance of micro-lesions that most often cause acute sensations of pain and discomfort (1994). Some studies have shown that the production of the lactic acid during exercise increases the pain [8,9].
Other studies have shown specially that aerobic exercise (10-30 minutes) reduced pain sensitivity across all types of pain stimuli and exercise types, with the largest effects found for studies using pressure stimuli [10-12] and the smallest effects on average for those using cold [13] and heat stimuli [14,15]. However, in the literature there is one study, that has tested pain thresholds using hot and cold thermal stimuli and found trivial effects and finding no effect of thermal stimuli 30 minutes post exercise[14]. And there is only few studies measured pain threshold and intensity immediately following dynamic resistance exercise [16,17]. The aim of this research is investigating the effect of resistance exercise on the level of perceived pain caused by the experimental thermal heat.

MATERIALS AND METHODS

Participants: The study was performed on 11 healthy male athletes (Mean age 23.5 ± 1.2 years). All subjects pursue 2-4 regular physical training sessions per week during 3 years in the Hassan II University, Casablanca. Exclusion criteria included known cardiac, pulmonary, or metabolic disorders, diseases affecting the sensory nerves, musculoskeletal disorders preventing safe participation in exercise. None of the subjects had impaired nociception. All of the subjects were informed of the purpose and procedures of the tests and informed consent was obtained prior to the commencement of the study.

Research Design: To prevent damage to the tissues at 52°C, the temperature sensor began to increase from a base temperature 48-51°C at a constant speed in a water bath a container filled with water heated electrically [4], whose temperature is controlled by an electronic thermometer. The chronometer system is stopped until the subject can no longer bear the heat pain. Duration of immersion (sec) from the time the right hand is placed in the water to the time it is voluntarily withdrawn. All subjects were evaluated at rest and after exercise (5 minutes).

Physical Exercise: The physical exercise test consisted of a 1000 m run, accomplished in a hot climate 30.7°C (Humidity values 64 %). Each subject ran from a standing position and ran 4 laps of 250 m; and used his own tactics to produce the best possible result. The running time for each subject was measured using an electronic timer accurate to 0.01 s. Before the test, all subjects performed a run of 10 minutes warm-up. Then we ask all the subjects to appreciate the effort at this race in a Borg RPE Scale.

Visual Analog Scale (VAS): The VAS was used to assess the experimental pain intensity induced by the hot water before and after exercise. The subjects mark the location on the 10-centimeter line corresponding to the amount of pain they experienced. This gives them the greatest freedom to choose their pain's exact intensity, from 0 ("No Pain") and 10 ("Maximum pain imaginable"). This scale is sensitive, reproducible, reliable and validated [18, 19].

Borg RPE Scale: The Borg Scale of Perceived Exertion was used to assess the effort perception during the physical activity. It extends from 6 to 20, in which 6 means "zero force" and 20 "Very difficult". We asked to tick the number that reflects more the perception of the each of participants' effort. This number will give us an idea of the intensity of physical activity.

Data Analysis: The data was analyzed using SPSS 20 (SPSS, Chicago, IL). The averages (Pre and post-exercise) were examined using a nonparametric Wilcoxon test for dependent samples. Pearson correlation coefficients were also computed between each pair of variables. The accepted level of significance was set at p<0.05. Data are reported as mean ± SD.

RESULTS

The effects of exercise on immersion time and pain perception level are shown in Figure 1. The comparison of means by Wilcoxon test showed, that immersion time after exercise decreased significantly (p<0.28) (12.78 ±3.87 vs 36.05 ±5,15). This reduction is estimated at 74.66 % compared to pre-exercise values. But the pain perception level significantly increased at 50, 09% (5.43 ±1.90 vs 8.86±1.46, p<0,041).

We observed a significantly negative high correlation, between the immersion time and the level of pain, respectively at rest and after exercise (r = -0.722, r = -0.699). This means that, the shorter is the immersion time of the hand, the greater the perception of pain (Table 1).

We also identified, a significantly negative high correlation (r = 0.846, p<0.008) between the run performance (In time) and Borg RPE value. The greater the intensity of exercise, the more intense are the perceptions of physical exertion.
Table 1: Correlation between variables measured at rest and after exercise

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Period</th>
<th>Pearson’s coefficient correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Immersion time (sec) vs Pain perception level</td>
<td>At rest</td>
<td>-0.722*</td>
</tr>
<tr>
<td></td>
<td>After exercise</td>
<td>-0.699*</td>
</tr>
<tr>
<td>Performance exercise vs pain perception level</td>
<td>At rest</td>
<td>0.025 NS</td>
</tr>
<tr>
<td></td>
<td>After exercise</td>
<td>-0.250 NS</td>
</tr>
<tr>
<td>Performance exercise vs Borg RPE value</td>
<td>After exercise</td>
<td>-0.846*</td>
</tr>
<tr>
<td>Pain perception level vs Borg RPE value</td>
<td>At rest</td>
<td>0.144 NS</td>
</tr>
<tr>
<td></td>
<td>After exercise</td>
<td>0.516*</td>
</tr>
</tbody>
</table>

* Significant comparison with p<0.05, Pearson's correlation coefficient (r).

Fig. 1: Immersion time (sec) of the hand and pain perception level at rest and after exercise. Average (± sd).
* p<0.05 (Comparison by Wilcoxon test)

And there is significant correlation (r = 0.516) between pain perception level and the difficulty of perceived exertion expressed by Borg RPE value.

**DISCUSSION**

The aim of our study is to evaluate the effect of resistance running on the ability to support an experimental heat. In other words, it’s to identify if it is some causal relationship between the intensity of physical activity and nociception of the individual to a thermal stimulus.

The results obtained from experiments show that there is a significant variation between the duration of immersion of the hand in the water bath at rest and after resistance exercise. Indeed, the aim of this experimentation is to stimulate the mecanonociceptor which are at the level of the skin in two networks: superficial (Epidermis) and deep (Dermis). So the integration of a thermal stimulus will lead to the release of K+ and H+, bradykinin, histamine, serotonin (5-HT), prostaglandins (PG), leukotrienes, proinflammatory cytokines, nerve growth factor (NGF) that act synergistically to cause pain to sensitize nociceptors to physical stimulus [20]. It is why the duration of immersion of the hand decreased after exercise. It shows why the subjects felt very badly to heated water by removing their hands very quickly. Indeed, during the experimentation, it was noted that the climate also plays a very important role and can influence the results.

The weather was very hot which made it possible to observe fatigue states. We should note that if the body temperature exceeds 33°C. This also implies probability of increasing the nociceptors sensibility level, that are not yet scientifically less well explained. The property of our hot water bath system is that it could adapt the degree of heat as required by the experimenter.

In fact, we note a tendency to decrease the duration of hand immersion in the hot water bath of 74.66% with a large dispersion between our subjects in the post-test. The perception of pain increases at 50.09% after exercise, which is consistent with experimental studies [21]. Reporting that perception of pain increases with thermal stimulus from 46°C.
Some studies have shown that the production of the lactic acid during session of eccentric training, increases the pain experienced, some effects may last up to two weeks after [8,9] increases the sensitivity of pain receptors of the whole body, by causing a reduced CNS drive to muscle.

In fact, induced acidosis can exacerbate fatigue during whole-body dynamic exercise (1-10 minutes) and alkalosis can deteriorates exercise performance [22]. Moreover, we noticed from our results that the assessment of pain perception level at resting is negatively correlated to the immersion time of the hand in hot water and this correlation level decreased significantly after exercise.

However, in most previous studies, the aerobic exercise reduced pain sensitivity across all types of pain stimuli and exercise types, with the smallest effects using cold [13,23] heat stimuli [14,15] and the largest effects using pressure stimuli [10-12].

The results of showed a negative correlation between physical performance and feelings of effort, strain, discomfort and fatigue recorded by RPE Scale. This shows that the more we look for the speed and chronometric performance the more the exercise will be felt difficult and unbearable.

Further experiments are required controlling pain experienced, sexe and climates (Hot vs cold), including exercises with varying intensity and different recovery time, sedentary vs trained athletes. More research is needed to determine the mechanism mechanisms of transfer of the suffering during the resistance exercise to nociceptive stimulus.

**CONCLUSION**

This work was carried out to evaluate the effect of resistance exercise realized in a hot climate on the ability to withstand the pain of experimental heat. The main results have shown a significant decrease in the ability to support an experimental heat and an increase in the pain perception. The resistance exercise performed in warm climate increases the sensitivity of pain physically perceived and felt. From this result we concluded that the body uses its own strategies to extend the suffering induced by resistance exercise to hot external stimuli.

**ACKNOWLEDGEMENT**

This study was supported by Hassan II Foundation for Scientific and Medical Research on Ramadan (FRSMR). We are grateful to the subjects who volunteered for this study.

**REFERENCES**


