Heat shock protein responses to eccentric weight or treadmill exercise in active young females

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Abstract Previous studies have shown the increase of heat shock protein (HSP72) following exercise in animals. The purpose of this study was to examine the effect of type of exercise on HSP72 response in active young females. Nineteen female physical education students were randomly divided into two groups: an endurance training group (ETG) and a weight training group (WTG). The exercise protocol in the ETG included incremental running to exhaustion performed at 65–75% VO_{2max} on a treadmill with a 0% grade. The subjects in the WTG also performed 4 sets of eccentric contractions of elbow flexors: two sets of 25 reps at 50% 1RM and two sets of 15–20 reps at 60% 1RM. Blood sampling from antecubital vein was done at baseline level (rest), mid-exercise and 30 min post-exercise in the same conditions, after a 12–14 h overnight fast. The samples were sent to a laboratory and centrifuged, and the serum used to analyse variables. A sandwich **Elisa and enzymatic assay were used for determination of HSP72 values and creatine kinase (CK) respectively. The data were analysed with repeated measures, LSD post hoc and independent t-test at \( p<0.05 \). The results showed HSP72 level alterations in mid- and post-tests were only significant in the ERG in comparison with baseline values \( (p=0.007, p=0.03 \) respectively). In addition, HSP72 level alterations within the ETG and WTG were only significant mid-test. Also CK levels insignificantly increased and decreased in the ETG and WTG respectively. The CK alterations in mid- and post-tests were insignificant between groups. Thus these results suggest that eccentric weight exercise induces a further increase in HSP72 levels.

Key words HSP72 · Endurance running · Weight exercise · Active females

Introduction

An appropriate and efficient stress response is vital for the survival of an organism, and one of the most prominent cellular responses to stress is a rapid change in gene expression to yield a family of highly conserved proteins known as heat shock proteins (HSPs) or stress proteins [1, 2]. Based on function and molecular weight, HSPs are categorised into: HSPs, HSP_{40,60,70,90} and 110 [3, 4]. HSP72 is the inducible form of the 70-kD family that is induced by stress and heat. These proteins increase due to various stressors such as increased temperature [5–8], mechanical stress [3, 9], protein degradation [3, 7, 10] and reduced glucose availability [2, 5, 6, 11]. An increased content of HSP72 following stress functions to restore cellular homeostasis, facilitate successful repair from injury and protect the cell against further insults [3, 12]. Many studies examined the effect of exercise as a stress on HSPs.
The effects of acute and chronic exercise stress on HSP72 in various animal species [6, 13–16] and humans [3, 5, 17–19] have been reported. Liu et al. [5] have demonstrated these changes in trained rowers: HSP70 protein expression increased to maximum levels after 3 weeks of endurance training, but decreased after the fourth and last week of exercise, when the exercise volume also decreased. Furthermore, some authors have investigated the HSP72 responses to acute endurance exercise. Walsh et al. [2] observed an increase of HSP72 levels immediately after a treadmill running at %70 VO2max. In contrast, Shastry et al. [20] and Puntschart et al. [21] did not find any increases in HSP72 with the same running training protocol. Moreover, the effect of exercise has been investigated in terms of intensity and duration on HSP72. Fehrenbach et al. [22] studied the effect of exercise intensity and duration on HSP72 and found the highest levels after competitive marathon running. Also, Liu et al. studied the effect of exercise intensity on HSP70 in highly trained rowers and found that exercise-induced elevations of HSP70 were dependent on intensity [23]. However it was not clearly defined whether this response depends on the type of exercise or not. Gjøvaag et al. [19] have described the effect of concentric or eccentric weight training on HSP72 in muscle biceps brachii of very well trained males and reported HSP72 expression decreased by 46.1% and 19.9% after 12 weeks of concentric and eccentric contractions, respectively. A logical planning of optimal exercise programmes to minimise muscle damage and maximise adaptation is a major concern of coaches and athletes [4]. Many studies have reported muscle fibre damage and Z-band streaming disruption following eccentric exercise and it has been shown that protein damage is a major stimulus of HSP72 expression [3, 7] and HSPs assist in the folding of newly synthesised proteins or in the refolding of incorrectly folded proteins [2, 4, 11, 18, 24, 25]. Therefore, in accordance with recent evidences we hypothesised that an acute bout of eccentric weight training of the elbow flexors would increase HSP72 levels as compared with endurance running exercise. Given most human exercise studies so far have used untrained subjects and little is known about the HSP response in active females, the present study was conducted to investigate whether HSP72 response is different following eccentric weight training or treadmill running exercise in active young females.

### Method

#### Subjects

Nineteen active female physical education students of Mazandaran University volunteered to participate in the study. Prior to participation, all subjects read and signed an informed consent document consistent with the guideline established by the ethics committee of the University of Mazandaran. They all avoided any exercise for at least 48 h before testing, as well as the use of alcohol, caffeine, tobacco and antioxidant supplements. They all resided in dormitories, had no history of disease or musculo-skeletal abnormality, did not use drugs during the course of study and had the required VO2max (taken based on Bruce test, 4–5 days before the first sampling). They completed an informed consent to participate in the study. Participants were then divided into two groups randomly: ETG (endurance training group on treadmill (n=9)) and WTG (weight training group (n=10)). The subjects’ characteristics are shown in Table 1.

#### Preliminary testing

At least 4–5 days before exercise, to determine the approximate time to exhaustion and VO2max, the participants performed the Bruce test on a treadmill in the ETG and one repetition maximum (1RM) of elbow flexion in the WTG. The laboratory temperature and humidity during all trials was 23±2°C and 55±5%, respectively.

#### Design and exercise protocols

The participants arrived in the laboratory according to the predetermined time after observance conditions to participate in study process at least 48 h before the trial. All subjects were non-weight trained for at least 6 months prior to this study. The subjects performed either eccentric weight training with elbow flexors or a treadmill running exercise. A circulating fan was placed in the lab during exercise to minimise thermal stress and improve ventilation [11]. At first, after determination of anthropometric variables and body composition, ETG subjects started the running exercise on a treadmill (0% grades) with a 3–5

### Table 1 Characterisation of subjects and exercise type: values are means

<table>
<thead>
<tr>
<th>Group</th>
<th>Age (years)</th>
<th>Weight (kg)</th>
<th>Height (cm)</th>
<th>VO2max (ml/min/kg)</th>
<th>Body fat (%)</th>
<th>BMI (kg/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ETG</td>
<td>20.25±1.16</td>
<td>59±10.14</td>
<td>163.46±4.63</td>
<td>38.60±6.10</td>
<td>22.25±6.03</td>
<td>22.15±4.19</td>
</tr>
<tr>
<td>WTG</td>
<td>19.60±0.51</td>
<td>59±9.02</td>
<td>161.24±8.10</td>
<td>37.87±5.24</td>
<td>21.24±3.13</td>
<td>22.26±2.43</td>
</tr>
</tbody>
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