ABSTRACT

INTRODUCTION. Mechanical efficiency (ME) may be a contributing factor in running performance. ME is the ratio between the amount of mechanical work performed and the amount of energy expended during exercise. PURPOSE. The purpose of this investigation was to determine the possible differences in ME and percent changes in ME with repetitive hopping between competitive and recreational long-distance runners. METHODS. Nine male runners (age 20±1.0 yrs; height 69.69±3.3 in; weight 70±14.9 kg) who ran at least 3 days a week were recruited. Participants reported to the lab on 2 days, separated by 1 week. On the first day, height, weight, and VO2max were measured. On the second day, participants completed 10 minutes of hopping on a force plate to determine ME. Subjects were classified as ‘recreational’ (Rec) or ‘competitive’ (Comp) based on self reported 1600m time and their VO2 max. RESULTS. The competitive group had a mean VO2max of 64±13.8 ml/kg/m, in 1600m time = 5:00 min, and ME of 43.98±3.04%. Percent change in ME between groups was −14.6±11.59% (p = 0.03). A correlation was observed between VO2max and % change in ME that trended toward significance (r = 0.49, p = 0.06). PRACTICAL APPLICATION. It appears that individuals categorized as competitive may maintain ME better than recreational runners (i.e. lower % change in ME). The ability to maintain ME during long duration stretch-shortening cycle exercise may be a factor pertaining to running performance.

BACKGROUND

• VO2 max is commonly used to describe and explain performance differences in runners, and although an important component, it is not the only factor that may contribute to overall running ability (1).

• Mechanical efficiency (ME) is defined as the ratio between the amount of mechanical work performed and the amount of energy expended during a given exercise bout (1). ME and changes in ME with repetitive stretch-shortening cycles may be possible contributors to running performance (2).

• Runners who use the stretch-shortening cycle effectively may be more mechanically efficient than those who don’t, and may have an increased running ability.

REFERENCES


RESULTS

Table 1. Results

<table>
<thead>
<tr>
<th>Group</th>
<th>1600 m Time†</th>
<th>VO2 Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comp</td>
<td>4.35 ± 0.06</td>
<td>64.12 ± 3.84</td>
</tr>
<tr>
<td>Rec</td>
<td>5.84 ± 0.92*</td>
<td>51.99 ± 1.63*</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Group</th>
<th>ME Beginning</th>
<th>ME End</th>
<th>% Change ME†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comp</td>
<td>43.98 ± 10.79</td>
<td>37.20 ± 8.81</td>
<td>-14.60 ± 11.59</td>
</tr>
<tr>
<td>Rec</td>
<td>42.67 ± 6.42</td>
<td>29.79 ± 7.07</td>
<td>-29.66 ± 17.02*</td>
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</tbody>
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* Indicates significant difference (p < 0.05) between groups for 1600 m time and VO2 max. ** Indicates nearing significance between groups for % change in ME (p = 0.05).

Figure 1. Mechanical Efficiency and Percent Change in Mechanical Efficiency

METHODS

Subjects

• Nine (9) male, recreational and competitive runners participated in this study (age = 20±1.0 yrs; mass = 70±14.9 kg; height = 177.0±8.3 cm).

• Subjects had to run at least 3 days a week to participate in this study.

• All procedures were approved by the Appalachian State University Institutional Review Board.

Experimental Design

• Subjects reported to the lab on two separate occasions, separated by one week.

• Session 1: Subjects were tested for height, weight, and VO2 max. VO2 max as analyzed on a Parvo Medics Metabolic cart.

• Session 2: Subjects completed 10 min of hopping on a force plate to determine ME with a weightless bar on their shoulders connected to linear position transducers to track hopping displacement. Blood lactate levels were tested before and immediately after the 10 min protocol.

Data Collection & Analysis

• ME was calculated using previously established methods (3).

• Change in ME was determined by comparing the first 3.33 min and last 3.33 min of the hopping protocol.

• Runners were classified as either ‘recreational’ or ‘competitive’ based on their self reported 1600m time and their VO2 max. (Recreational: VO2 max < 60.0 ml/kg/m, 1600m time ≥ 5:00 min; Competitive: VO2 max ≥ 60 ml/kg/m, 1600m time < 5:00 min)

SUMMARY AND CONCLUSIONS

• Although initial ME was not significantly different between Rec and Comp groups a greater decline in ME was observed in Rec.

• An statistically significant inverse correlation was found between change in ME and running time. Subjects who have the least amount of change in their mechanical efficiency reported the fastest times in the 1600m run.

• This indicates that future research is needed to determine if the ability to maintain ME during an exercise bout of repetitive stretch-shortening cycles may be a contributing factor in long distance running performance.