The purpose of this study was to investigate the relationships between changes in running economy and running mechanics by using a segment kinematics approach. Six male university distance runners performed treadmill running before and after the 4 month period, while oxygen consumption and running motion were also measured. Mechanical power was calculated by a segment kinematics approach, the data for 4 of 6 subjects were analysed. Running economy for 2 of 4 subjects were improved and mechanical power were decreased. Running economy for the other 2 subjects deteriorated but change in mechanical power was different for one subject which decreased while for increasing for another subject. The relationships between changes in running economy and running mechanics varied with the individual runner.

KEY WORDS: mechanical power, running economy,
center of mass; and \( \omega_i \) = the angular velocity for segment. Mechanical work by assuming the transfer of energy both within and between segments, mechanical work (Wwb) was calculated by equation (2):

\[
W_{wb} = \sum_{j=1}^{n} \sum_{i=1}^{g} \left( \Delta E_{i,j} \right)
\]

Mean power was calculated by dividing the mechanical work by a cycle time.

RESULTS: Table 1 shows height, weight and those change ratios for each subject before and after the 4 month period. Mean change ratio of height was -0.2±0.2 % and it of weight was -0.4±2.6 %. Table 2 shows VO\(_2\) and mechanical power at 15.0 and 16.2 km/h and VO\(_2\)peak for each subject before and after the 4 month period. VO\(_2\) at 15.0 and 16.2 km/h for subject 1 and 2 increased from before to after, while for subjects 4, 5 and 6 decreased from before to after. Mechanical powers of subject 1 and 2 who’s VO\(_2\) increased and subject 4 and 5 who’s VO\(_2\) decreased were calculated at after. Mechanical power at 15.0 and 16.2 km/h for subject 1, 2 and 5 decreased from before to after, while subject 4 increased from before to after. Figure 1 shows the relationship between change ratio in VO\(_2\) (\( \Delta \) VO\(_2\)) and it in mechanical power (\( \Delta \) Mechanical power). Both \( \Delta \) VO\(_2\) and \( \Delta \) Mechanical power for subject 4 and 5 were negative values, and these for subject 2 were positive values.

**Table 1**

Height and weight before and after the 4 month period.

<table>
<thead>
<tr>
<th>Subject</th>
<th>Before</th>
<th>After</th>
<th>Change ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Height</td>
<td>Weight</td>
<td>Height</td>
</tr>
<tr>
<td>1</td>
<td>177.4</td>
<td>58.8</td>
<td>177.2</td>
</tr>
<tr>
<td>2</td>
<td>168.5</td>
<td>53.0</td>
<td>168.5</td>
</tr>
<tr>
<td>3</td>
<td>166.5</td>
<td>56.8</td>
<td>166.2</td>
</tr>
<tr>
<td>4</td>
<td>169.0</td>
<td>58.0</td>
<td>168.5</td>
</tr>
<tr>
<td>5</td>
<td>165.5</td>
<td>56.3</td>
<td>164.5</td>
</tr>
<tr>
<td>6</td>
<td>164.4</td>
<td>53.9</td>
<td>164.5</td>
</tr>
<tr>
<td>Mean</td>
<td>168.6</td>
<td>56.1</td>
<td>168.2</td>
</tr>
<tr>
<td>SD</td>
<td>4.7</td>
<td>2.3</td>
<td>4.7</td>
</tr>
</tbody>
</table>

Heigh units: cm, Weight units: kg, Change ratio units: %

**Table 2**

VO\(_2\) and mechanical power before and after the 4 month period.

\[
\begin{array}{cccccc}
\text{Subject} & \text{VO}_2 & \text{VO}_2 & \text{VO}_{2\text{peak}} & \text{Mechanical power} & \text{Mechanical power} \\
& @15.0km/h & @16.2km/h & @15.0km/h & @15.0km/h & @16.2km/h \\
\hline
1 & 47.4 & 51.2 & 66.2 & 15.7 & 17.5 & 52.0 & 55.7 & 71.1 & 12.7 & 13.5 \\
2 & 52.8 & 55.6 & 77.9 & 12.3 & 11.5 & 54.0 & 61.0 & 89.0 & 14.9 & 14.3 \\
3 & 48.4 & 55.6 & 78.4 & 11.8 & 11.8 & 46.6 & 61.0 & 79.3 & - & - \\
4 & 54.0 & 62.8 & 69.2 & 14.1 & 12.6 & 49.3 & 55.0 & 78.6 & 9.0 & 11.7 \\
5 & 52.6 & 56.7 & 72.8 & 10.9 & 12.1 & 48.2 & 54.4 & 73.7 & 7.9 & 9.3 \\
6 & 55.8 & 60.8 & 73.9 & 11.6 & 9.5 & 52.2 & 60.5 & 76.8 & - & - \\
\text{Mean} & 51.8 & 57.1 & 73.1 & 12.7 & 12.5 & 50.4 & 57.9 & 78.1 & 11.1 & 12.2 \\
\text{SD} & 3.3 & 4.1 & 4.8 & 1.8 & 2.7 & 2.8 & 3.2 & 6.2 & 3.2 & 2.2 \\
\end{array}
\]

VO\(_2\) units: ml/kg/min, Mechanical power units: W/kg
DISCUSSION: Anthropometric characteristics have the potential to affect running economy and mechanics. Both height and weight for subject 1, 2, 4 and 5 showed very little change (Table 1). Therefore, these changes have little effects on changes in running economy and mechanical power in this study. Running economy at 15.0 and 16.2 km/h for subject 4 and 5 were improved and mechanical power at those velocities were decreased (Figure 1). This suggests that improved running economy for subject 4 and 5 are affected by improving running mechanics. Especially, in spite of VO_{2peak} for subject 4 was increased from 69.2 to 78.6 ml/kg/min, his running economy was markedly improved. Running economy for subject 1 and 2 were deteriorated but changed in mechanical power was different as it for subject 1 was decreased while it for subject 2 was increased (Figure 1). Subject 2 is a runner who deteriorated running economy by deteriorating running mechanics and increasing VO_{2peak}. On the other hand, subject 1 is a runner who deteriorated running economy in spite of improving running mechanics. One reason of deteriorated running economy for subject 1 is increased his VO_{2peak} from 66.2 to 71.1 ml/kg/min.

CONCLUSION: The relationships between changes in running economy and running mechanics are varied with individual runners. The changes in running economy are affected by not only running mechanics but also other factors as VO_{2peak}. This study indicated that improving running mechanics is one of the factors affected to changes in running economy, and it has the potential to improving running economy.

REFERENCES: