The Biomechanics of Distance Running: What is “Optimal” Technique

Iain Hunter
Brigham Young University
iain_hunter@byu.edu

Body Type
- Tall & short
- Heavy & Light

Body Type

Stride Length & Rate

Running on Level Ground
Running When Fatigued

Hill Running

Inexperienced Runners

Lower Body Mechanics & Velocity

3D Modeling
- Stride Length and Rate
- Knee Swing Angle
- Max Hip Flexion
- Max Hip Extension

- Plantar Flexion Velocity
- Vertical Oscillation
- Knee Range
**Lower Body Mechanics & Velocity**

**Stride Rate & Length**

<table>
<thead>
<tr>
<th>Speed (m/s)</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stride Rate</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>Stride Length (m)</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
</tr>
</tbody>
</table>

- **Athlete**
  - Lagat: 4.00
  - Jennings: 3.57
  - Manzano: 3.70
  - Lukezic: 4.08

**Knee Swing Angle**

- Women
- Men

**Maximum Hip Flexion**

<table>
<thead>
<tr>
<th>Speed (m/s)</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angle (deg)</td>
<td>90</td>
<td>80</td>
<td>70</td>
<td>60</td>
<td>50</td>
<td>40</td>
</tr>
</tbody>
</table>

**Maximum Hip Extension**

<table>
<thead>
<tr>
<th>Speed (m/s)</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angle (deg)</td>
<td>-50</td>
<td>-40</td>
<td>-30</td>
<td>-20</td>
<td>-10</td>
<td>0</td>
</tr>
</tbody>
</table>

**Plantarflexion Velocity**

<table>
<thead>
<tr>
<th>Speed (m/s)</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angle (deg)</td>
<td>1000</td>
<td>900</td>
<td>800</td>
<td>700</td>
<td>600</td>
<td>500</td>
</tr>
</tbody>
</table>
Lower Body Mechanics & Velocity

Vertical Oscillation

Knee Range

How Smart is Your Body?

Upper Body Mechanics

- Purpose of the Upper Body
- Newton’s Third Law of Motion
Upper Body Mechanics

For every action, there is always opposed an equal and opposite reaction.

Can You Run in a Straight Line?

Optimal Upper Body Movement

Should abnormalities be “corrected”?

What is Optimal Technique?

Current training state

Future plan

How to Change Running Mechanics

Sprinting Technique

<table>
<thead>
<tr>
<th>Sprinters</th>
<th>Distance Runners</th>
<th>Non-runners</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stride Length at Max Velocity</td>
<td>4.45 m</td>
<td>4.04 m</td>
</tr>
<tr>
<td>Contact time at Max Velocity</td>
<td>0.109 s</td>
<td>0.124 s</td>
</tr>
<tr>
<td>Recovery Knee at TD at Max Velocity</td>
<td>0.40 m</td>
<td>0.54 m</td>
</tr>
<tr>
<td>GR at Touchdown</td>
<td>0.68 m</td>
<td>0.72 m</td>
</tr>
<tr>
<td>Minimum Hip Angle</td>
<td>101°</td>
<td>112°</td>
</tr>
</tbody>
</table>
### Sprinting Technique

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<tr>
<th></th>
<th>Sprinters</th>
<th>Distance Runners</th>
<th>Non-runners</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stride Length at 4:37 min/mi pace</td>
<td>3.88 m</td>
<td>3.66 m</td>
<td>3.72 m</td>
</tr>
<tr>
<td>Contact time at 4:37 min/mi pace</td>
<td>0.168 s</td>
<td>0.177 s</td>
<td>0.187 s</td>
</tr>
<tr>
<td>Recovery Knee at 4:37 min/mi pace</td>
<td>0.46 m</td>
<td>0.59 m</td>
<td>0.62 m</td>
</tr>
<tr>
<td>CM at Touchdown 4:37 min/mi pace</td>
<td>0.71 m</td>
<td>0.76 m</td>
<td>0.76 m</td>
</tr>
<tr>
<td>Minimum Hip Angle 4:37 min/mi pace</td>
<td>117°</td>
<td>125°</td>
<td>125°</td>
</tr>
</tbody>
</table>

### Improved Running Economy


### Finishing a Race

- Marla Runyan and Shane Culpepper

### Distance Runners vs Sprinters

- Do not consciously change running technique
- Running economy and performance times
- Plyometrics leading to changes in technique

### Summary