Variability in Baseball Throwing Metrics During a Structured Long-Toss Program: Does one size fit all or should programs be individualized?

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Background

- Structured long-toss used for rehabilitating pitchers.
- Programs vary, but many are not individualized.
- Max-distance throwing results in large variation in throwing metrics.
- Limited data on intra- and inter-thrower reliability in throwing metrics during long-toss.

Purpose

- Describe the progression of throwing metrics through a structured long-toss program. Assess intra-thrower and inter-thrower reliability for ball velocity and elbow varus torque in pitchers completing the program.

Methods

- 60 healthy high school and collegiate pitchers participated in pre-determined, progressive long-toss program:
  - 5 full-effort throws at 90 ft, 120 ft, 150 ft, 180 ft, and from mound
- Metrics: elbow varus torque, ball velocity, arm slot, arm speed, shoulder rotation
- Radar gun measured ball velocity. motusBASEBALL sensor sleeve (Motus Global) measured other metrics.
- Intra- and inter-thrower reliabilities calculated at every distance.

Results

Progression of metrics through long-toss program

<table>
<thead>
<tr>
<th>Distance</th>
<th>90 ft</th>
<th>120 ft</th>
<th>150 ft</th>
<th>180 ft</th>
<th>Mound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arm Slot (°)</td>
<td>50</td>
<td>48</td>
<td>48</td>
<td>47</td>
<td>50.6</td>
</tr>
<tr>
<td>Arm Speed (&gt;s)</td>
<td>5203</td>
<td>5302</td>
<td>5357</td>
<td>5407</td>
<td>5527</td>
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<tr>
<td>Shoulder Rotation (°)</td>
<td>161.5</td>
<td>167.0</td>
<td>170.0</td>
<td>173.4</td>
<td>160.9</td>
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<tr>
<td>Elbow Torque (N·m)</td>
<td>67.7</td>
<td>69.7</td>
<td>70.7</td>
<td>71.2</td>
<td>71.1</td>
</tr>
<tr>
<td>Ball Velocity (MPH)</td>
<td>69.6</td>
<td>72.2</td>
<td>73.4</td>
<td>74.5</td>
<td>77.8</td>
</tr>
</tbody>
</table>

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<thead>
<tr>
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<th>150 ft</th>
<th>180 ft</th>
<th>Mound</th>
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<tbody>
<tr>
<td>p-value</td>
<td>0.04*</td>
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<td>0.002</td>
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<td>&lt;0.001</td>
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</tbody>
</table>

Intra-class correlation coefficient (ICC) was >0.75 at all distances for elbow torque and ball velocity

ICC<0.40 = poor
ICC 0.40-0.59 = fair
ICC 0.60-0.75 = good
ICC >0.75 = excellent

Intra-thrower reliabilities

Inter-thrower reliabilities

*After applying the stepdown Bonferroni adjustment, no pairwise comparisons were significant.

Significant post-hoc differences are indicated with the following superscripts: (a) 90 ft-120 ft; (b) 90 ft-150 ft; (c) 90 ft-180 ft; (d) 90 ft-mound; (e) 120 ft-150 ft; (f) 120 ft-180 ft; (g) 120 ft-mound; (h) 150 ft-180 ft; (i) 150 ft-mound; (j) 180 ft-mound.

Progression of elbow torque and ball velocity

- No significant changes in elbow torque between distances ≥ 120 ft
- Throwing from mound does not place significantly more torque on the elbow than throwing at 120 ft
- Ball velocity increased significantly at each progressive distance and at the mound

Conclusion

- Ball velocity significantly changed at each progressive throwing distance.
- Elbow torque did not significantly change ≥ 120 ft long-toss.
- It may be feasible to incorporate mound throwing earlier in rehab process.
- Exercise caution when relying on radar guns to estimate elbow torque.
- Some athletes would likely benefit from individualized long-toss throwing program.