THE EFFECT OF TWO DIFFERENT WEIGHTED BADMINTON Rackets
ABOUT VELOCITY AND TORQUE WHEN OUTSTANDING BADMINTON
PLAYERS WAS PERFORMING SMASH MOVEMENT

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The purpose of this research is to study and to analyze the relationship of the velocity and
torque between two different weighted badminton rackets while the elite players was
performing the smash movement. All the data of this study is filmed by digital video (60Hz/s)
and is analyzed on the space of 2D by sagittal plane and horizontal axis movement of the
participator. In order to derive the primary parameters of smash motion, including
velocity, movement of inertia, angular acceleration, torque. The data are digitized and
filtered in APAS (the Ariel Performance Analyze System). As a result, by T-Test, the
T-values are up to the observable level, and the level a is 0.05.

KEY WORDS: smash, velocity, moment of inertia, angular acceleration, torque.

INTRODUCTION: Smashing is the key point to win in the badminton game. Besides the skill,
the weight of the racket is the most important factor that athletes can dominate easily. A
constant theory is those who want to change the state of action must overcome the inertia of
racket. To gain the most advantage in the game, one must try to obtain more inertia of rotation
to decrease the torque. During the past few years, the researches about this field were not
treated seriously. So this study can set up the parameters of model for both teachers and
coaches.

METHODS: Four outstanding female badminton players (age 20.3 ± 3.2yrs, tall 163 ±
5.2cm, weight 54.8 ± 3.9kg, competition experience 10.3 ± 2.8yrs) are served the subjects for this
study. They were recorded by a digital video (JVC GR-DVL9800, 60Hz/s) while using two
different weighted rackets to smash. Then the film was trimmed, digitized, direct linear
transformed and filtered in APAS system to obtain the variables of velocity, angular
acceleration. The center of mass (CM) and the weight of three-segments (upper arm, fore arm,hand with the racket) were evaluated, which quote from Dempster’s and Jin-cheng Wang’s
parameter (table 1). First, we must calculate the center of gravity between the hand and the
racket according to Parallel Theory. Then we estimate the center of three-segments (including
the rackets), the outcome can be the parameters of moment of inertia (formula 1,2). The
variables of data shows details in figure 1.

Table 1 The Data of Three-segments and Racket about Participators.

<table>
<thead>
<tr>
<th></th>
<th>upper-arm</th>
<th>fore-arm</th>
<th>hand+racket(85g)</th>
<th>hand+racket(100g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>length(cm)</td>
<td>30.55±2.28</td>
<td>23.75±1.7</td>
<td>66.5</td>
<td>66.5</td>
</tr>
<tr>
<td>weight(kg)</td>
<td>1.48±0.12</td>
<td>0.88±0.07</td>
<td>0.41±0.0275</td>
<td>0.429±0.0275</td>
</tr>
<tr>
<td>length(cm)</td>
<td>13.75±1.0</td>
<td>10.85±0.75</td>
<td>13±0.346</td>
<td>13.5±0.356</td>
</tr>
<tr>
<td>(from segment’ CM to shoulder joint)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Where $I_0$ is the moment of inertia that is the fulcrum for shoulder joint while smashing, and $I_g$ is the sum of moment of inertia from three-segments and racket.
RESULTS AND DISCUSSION: Table 2 shows the velocity of both different rackets. Very obviously, the velocity of heavier racket (100g) is much faster than the lighter one (85g) while smashing. And the T-values are up to apparently level by T-Test (the level is 0.05). The stability is the variable standard deviation divide into the velocity. So if concerning the stability of a smash action, a heavier racket (92%) will surely has more advantages over the other one (88.7%).

Table 2 The Testing Result of the Velocity of both different Racket.

<table>
<thead>
<tr>
<th></th>
<th>racket(85g)</th>
<th>racket(100g)</th>
<th>T-values</th>
</tr>
</thead>
<tbody>
<tr>
<td>velocity</td>
<td>65.99±7.48</td>
<td>69.42±5.49</td>
<td>-3.78*</td>
</tr>
<tr>
<td>stability</td>
<td>88.7%</td>
<td>92%</td>
<td></td>
</tr>
</tbody>
</table>

*p<.05

Table 3 shows the kinetics variables of both different weighted badminton rackets during the movement of smashing. The angular velocity of weightier racket is much faster than the other one, and so is the angular acceleration. According to the formula of torque, it was equal to angular acceleration multiplied by the moment of inertia of the hand and racket (formula 3). Due to the both moment of inertia are very closely. So the heavier one can obtain faster velocity of badminton in the smash action.

Table 3 The Kinematics Variables of Badminton Smash.

<table>
<thead>
<tr>
<th></th>
<th>racket(85g)</th>
<th>racket(100g)</th>
<th>T-values</th>
</tr>
</thead>
<tbody>
<tr>
<td>angular velocity</td>
<td>17±4.48</td>
<td>19.4±3.97</td>
<td></td>
</tr>
<tr>
<td>angular acceleration</td>
<td>1032±268.8</td>
<td>1164±238.2</td>
<td></td>
</tr>
<tr>
<td>moment of inertia</td>
<td>0.37±0.073</td>
<td>0.39±0.078</td>
<td></td>
</tr>
<tr>
<td>torque</td>
<td>381.84±19.62</td>
<td>453.96±18.58</td>
<td>-162.09*</td>
</tr>
</tbody>
</table>

Torque(T) = Moment of Inertia(I) × angular acceleration(a)------formula 3

*p<.05

CONCLUSION: This study demonstrates the biomechanical variables that can be caused by the two different weighted rackets when the elite players are smashing. The steadiness of smash movement goes up to 92% when they use the heavier racket. However, a lighter one just only reach 88.7% in the same action. As the shoulder joint be the fulcrum, the angular acceleration of smack movement was much faster while holding the heavier one. Because the variables of both moments of inertia are very close, the heavier racket can absolutely be superiority to the lighter one in torque.

REFERENCE: