



**UNIVERSITY OF  
TECHNOLOGY SYDNEY**

FACULTY OF BUSINESS

SCHOOL OF LEISURE SPORT AND TOURISM

## **Biomechanics of the Baseball Swing**

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This thesis is submitted to fulfil the requirements for the degree Masters by Research  
(Sport Studies) at the University of Technology, Sydney, August, 2010.

# *Certificate of Originality*

I certify that the work in this thesis has not been previously submitted for a degree nor has it been submitted as part of requirements for a degree except as fully acknowledge within the text.

I also certify that the thesis has been written solely by me. Any help that I have received in my research work and the preparation of thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

Signature of candidate

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# ***Dedication***

This thesis is dedicated to my parents. They are still the two most knowledgeable people I know and have always been there to support me through my studies.

# *Abstract*

The purpose of this research was to describe the kinematics of the baseball swing. In particular, this study aimed to determine differences in bat swing kinematics in hitters of varying ability. Further, changes in swing pattern that occur when using bats of varying mass were also observed.

Twenty sub-elite male baseballers participated in the study ( $22.3 \pm 5.3$  yr,  $1.82 \pm 0.07$  m,  $83.5 \pm 10.9$  kg). Three baseball bats of equal length (0.838m) and varying mass (Bat<sub>1</sub> = 0.795kg, Bat<sub>2</sub> = 0.847kg, Bat<sub>3</sub> = 0.943kg) were used. Each subject performed 10 maximal swings with each bat at a ball on a hitting tee replicating a line drive. Infrared cameras obtained high speed three-dimensional data to quantify the biomechanics during the baseball swing. One-way ANOVA was used to determine kinematic differences between conditions. In addition, the participants were ranked prior to testing based on a novel coach's rating scale and seasonal batting average. They were subsequently separated into a relatively good group of hitters (n=10) and a relatively poor group of hitters (n=10) for comparison. Importantly, the two groups were significantly different in terms of coach's rating ( $p < 0.01$ ) and batting average ( $p < 0.05$ ).

The results showed a significant difference in maximum bat swing velocity ( $p < 0.05$ ) with good hitters having a higher velocity ( $36.8 \text{ m}\cdot\text{s}^{-1}$ ) in comparison to relatively poor hitters ( $33.8 \text{ m}\cdot\text{s}^{-1}$ ). Left elbow maximum angular velocity was significantly higher (35.9%) amongst relatively good hitters ( $p < 0.05$ ). Good hitters also had a right knee angle of  $106^\circ$  at ball contact which was significantly ( $p < 0.05$ ) higher than relatively poor hitters ( $100^\circ$ ). There were no between-group differences for wrist and hip joint velocities at ball contact.

The results also showed a difference in maximum bat swing velocity ( $p < 0.01$ ) between Bat<sub>1</sub> ( $36.0 \text{ m}\cdot\text{s}^{-1}$ ) and Bat<sub>3</sub> ( $34.4 \text{ m}\cdot\text{s}^{-1}$ ). Resultant ball velocity was 17% higher using Bat<sub>1</sub> compared to Bat<sub>3</sub> ( $p < 0.05$ ). Subject head movement was lower using Bat<sub>1</sub> (8 cm) when compared to Bat<sub>3</sub> (10 cm). Maximum linear left hip velocity was significantly higher ( $p < 0.01$ ) when using Bat<sub>3</sub> compared to other bats. In contrast, maximum linear right hip velocity was lower ( $p < 0.01$ ) when using Bat<sub>3</sub>.

This study established that bat swing velocity is a key characteristic of the baseball swing when identifying skill level and performance between hitters. Additionally, good hitters display greater lead elbow maximum angular velocity. Future research should develop and evaluate specific baseball training programs designed primarily to improve these two aspects of the baseball swing. Further, this study has identified aspects of the baseball swing that differ when using bats of varying mass. Notably, a relationship exists between bat mass and hip linear velocity which could be a

potential mechanism for underlying training effects. Further studies are needed to determine acute and longitudinal kinematic effects of using bats of varying mass.

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$$I = (1/4)MR^2 + (1/12)ML^2$$

Equation 2 – Moment of Inertia ..... 28

$$I_o = \frac{T^2 \bullet w \bullet r}{4\pi^2}$$

Equation 3 – Radius of Gyration ..... 28

$$k = \sqrt{\frac{I_o}{m}}$$

Equation 4 – Centre of Percussion ..... 29

$$q = \frac{k^2}{r}$$

Equation 5 – Coefficient of Restitution ..... 30

$$e_o = -\frac{v' - V'}{v - V}$$

# *List of Abbreviations*

<b>3D</b>	Three Dimensional
<b>ANOVA</b>	Analysis of Variance
<b>BP</b>	Batting Practice Group
<b>BSV</b>	Bat Swing Velocity
<b>BSV<sub>con</sub></b>	Bat Swing Velocity at Contact
<b>BSV<sub>max</sub></b>	Maximum Bat Swing Velocity
<b>BV<sub>max</sub></b>	Maximum Resultant Ball Velocity
<b>CG</b>	Control Group
<b>COP</b>	Centre of Percussion
<b>COR</b>	Coefficient of Restitution
<b>°</b>	Degrees
<b>°·s<sup>-1</sup></b>	Degrees per second
<b>DS</b>	Dry Swing Group
<b>Hz</b>	Hertz
<b>ICC</b>	Interclass Correlation
<b>in</b>	Inches
<b>kg</b>	Kilograms
<b>KP</b>	Kilopond
<b>LEAV<sub>max</sub></b>	Maximum Left Elbow Angular Velocity
<b>m</b>	Metres
<b>m·s<sup>-1</sup></b>	Metres per second
<b>MLB</b>	Major League Baseball

<b>MOI</b>	Moment of Inertia
<b>NCAA</b>	National Collegiate Athletic Association
<b>NSWML</b>	New South Wales Major League
<b>oz</b>	Ounces
<b>RPM</b>	Revolutions per minute
<b>SD</b>	Standard Deviation
<b>SPSS</b>	Statistical Package for the Social Sciences
<b>TEM</b>	Technical Error of Measurement
<b>USA</b>	United States of America
<b>WBC</b>	World Baseball Classic
<b>yrs</b>	Years

# *List of Publications*

Inkster, B., Murphy, A., Bower, R. & Watsford, M. Differences in the kinematics of the baseball swing between hitters of varying skill. (In Press: *Medicine and Science in Sports and Exercise*).

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