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THE EFFECTS OF STRIDE ON BAT SWING TIME IN SLO-PITCH HITTING

Tom Wu[1], Pierre Gervais[2], Pierre Baudin[2] and Marcel Bouffard[2]

[1]Department of Movement Arts, Health Promotion and Leisure Studies, Bridgewater State University, Bridgewater, United States
[2]Faculty of Physical Education and Recreation, University of Alberta, Edmonton, Canada

The purpose of this study was to examine the influence of stride technique on the bat swing time in the skill of slo-pitch hitting. Ten elite players participated in the study, and each hit twelve balls with each of three different stride techniques. A three-dimensional bat swing analysis was conducted, and the results showed that the participants did not show any statistical significance between different stride techniques in bat swing time. This study suggests that participants may use all three stride techniques of open, parallel, and close to hit the ball effectively. Future research studies are warranted to examine the influence of pitched ball locations and ball field placement locations on bat swing time.

KEY WORDS: batting, closed, open, parallel, softball

INTRODUCTION: A batting skill is considerably different from a pitching skill. Batting requires a batter to anticipate a pitched ball and strike it with a bat accurately. Research studies on baseball batting mechanics have either focused on the mechanics of body motion or the characteristics of bat swing motion. Shapiro (1979) examined the kinematics and kinetics of a baseball bat swing with a 3D cinematographic method. A varsity baseball player was the only participant in the study. Instead of using a pitching machine, a former varsity pitcher threw baseballs toward the batter at approximately 25 m/s. Two Locam cameras were placed along the first baseline to capture the front view of the batter. The batter hit several balls, and the three best hits were chosen for analysis. He reported that, from the starting position, the movement of the bat started in a downward motion and then, prior to ball contact, the bat started to move in an upward motion. This bat swing motion is supported by several former baseball players, coaches, and scientists (Hames, 1975; Koike et al., 2003; Lopiano, 1978; Williams, 1968). In addition, the total swing time from the beginning of the bat swing to ball contact was reported to be 0.25 s. In a game of slo-pitch softball, the ball is pitched at a speed of 10-15 m/s and takes approximately 1.5 s to reach home plate (Wu & Gervais, 2006, 2008). In baseball and fast pitch softball, the ball is thrown at a higher speed of 35-40 m/s and 20-25 m/s, respectively (Escamilla et al., 2001; Hay, 1978; Messier & Owen, 1985, 1986; Oliver, 2003). The batter only has approximately 0.5 s to hit the ball before it crosses the home plate (Hay, 1978). Since the ball is pitched at a moderate velocity in slo-pitch softball, the batter has sufficient amount of time to use either an open, parallel, or closed stride to hit the ball. The advantage of using different stride techniques is enabling the slo-pitch batter to strike the ball at the sweet spot of the bat more consistently. If a batter can have a shorter bat swing time with a particular stride technique, the batter will then be able to produce a higher linear and angular velocities of the bat swing, which will enable the batter to hit the ball farther. The question pertains to which stride technique would have the shortest bat swing time, which may be more effective to use, in slo-pitch batting remained to be answered. Therefore, the purpose of this study was to examine the effects of stride technique on bat swing time in slo-pitch hitting.

METHODS: Ten right-handed elite male slo-pitch players (mean age = 33.7 ± 5.0 years, height = 1.8 ± 0.1 m, mass = 93.5 ± 21.0 kg and playing experience = 12.7 ± 5.5 years) participated in the study. This study was approved by the institutional research ethics review board, and written informed consent was obtained from all participants prior to the study. The study was conducted in an indoor field house to control the influence of air forces. All players used a Easton Cyclone SK37 0.78 kg and 0.86 m (28 oz and 34”) bat with two reflective markers placed at the top and bottom of the bat. Wu and Gervais (2006, 2008) indicated that the slo-pitch pitcher’s stride length was approximately equal to 0.80 m; hence, the actual distance between the batter and pitching machine was calculated as 14.44 m. Therefore, a Jugs Lite-Flite pitching machine (Jugs Softball, Jug Inc., Tualatin, OR) was placed 14.44 m away from the batter to simulate the actual hitting distance between the pitcher and the batter. Additionally, a blue mat was placed in front of the pitching machine so that the batter could not see from where the balls were pitched to better simulate conditions a batter may face in a real game situation. Twenty-four Jugs Lite-Flite indoor softballs, 0.30 m (12”), were used in the study. Small strips of reflective tape were placed on the surface of the balls (weight = 0.07 kg) in order to identify the instant of ball contact. The balls were thrown at a speed of approximately 13.55 ± 0.77 m/s with an arc trajectory of 2.72 ± 0.22 m. Participants performed their regular warm-up routine and took batting practice until they were ready for testing. Each participant stood at their own self selected location in the batter’s box with their own natural stance. Participants hit twelve balls with each stride technique (open, parallel and closed). An open stride technique was defined as when the particpant stride toward the same field (left field) at an angle greater than 30° in a counter-clockwise direction while a close stride was defined as when the particpant stride toward the opposite field (right field) at an angle greater than 30° in a counter direction. A parallel stride was defined as when the participant stride toward the pitching machine at an angle less than 30° in either a clockwise direction or a counter-clockwise direction. During the testing, the participant had 30 s to rest between hitting each ball, and one minute to rest between using each type of stride. The influence of fatigue and the risk of injury were minimal in this study. The bat swing time was defined as when the front foot began striding forward toward the pitching machine until ball contact. A total of 36 balls were hit by each participant; hence, a total of 360 trials were collected in this study. The order of the stride technique was randomized to reduce any order effect. A three-dimensional (3D) analysis was conducted with an 8-camera Qualisys motion capture system (ProReflex MCU 240, Qualisys AB, Sweden) that was operated at 240 Hz. Six cameras were placed approximately 60° apart inside a soccer net in front and on the back of the particpant to capture the anterior and the posterior views of the bat movement, respectively. Additonal two cameras were placed on the right side of the participant on top of a balcony that is approximately 5 m above the ground to capture the superior view of the bat movement. A wand calibration technique was used to calibrate the volume that was 2.5 m in each of X, Y and Z directions. Data was smoothed with 4^{th} order Butterworth filter, and the cut-off frequency for the x-coordinate ranged from 6.3 to 12.2 Hz; the y-coordinate ranged from 6.1 to 11.6 Hz, and the z-coordinate ranged from 6.3 to 10.8 Hz. A one-way repeated measure ANOVA was conducted at $\alpha = 0.05$ followed by a dependent sample t-test with Bonferroni adjustment if a significant difference was found.

RESULTS: The parallel stride technique had the shortest bat swing time of 0.570 ± 0.144 s while the open stride technique had the longest bat swing time of 0.600 ± 0.136 s. However, there was no statistical significant difference between all three stride techniques in bat swing time. From the results of the study, on average, the heel of the front foot was planted on the ground approximately at 0.372 s after swing initiation (65 % of bat swing time). The back elbow (right elbow) began to drop to the hip level which allowed the bat to accelerate downward. At this time the lower body, trunk and upper body joint angles and velocities began to increase or decrease depending on type of joint movement and coordination pattern. Further, on average approximately at 0.493 s (85% of the bat swing time), the bat began to accelerate upward, and then the upper body joint velocity reached its peak velocity approximately at 0.544 s (95% of bat swing time). On average bat then reached its maximum linear and angular velocities approximately at 0.553 s (96 % of the bat swing time). The mean duration of bat swing was approximately 0.586 ± 0.144 s, which was determined from the time the front foot started stride toward the ball or the pitching machine until ball contact. After ball contact the body and the bat continued to rotate to complete the follow through movement.

Table 1
Comparisons of Stride Technique in Bat Swing Time

Stride Techniques	Mean ± SD		*p*
Open vs Parallel (s)	0.600 ± 0.136	0.570 ± 0.144	1.00
Closed vs Parallel (s)	0.589 ± 0.158	0.570 ± 0.144	1.00
Open vs Closed (s)	0.600 ± 0.136	0.589 ± 0.158	1.00

* Statistical significant at $p < 0.02$

DISCUSSION: In a game of slo-pitch the ball is pitched to the batter at an arc trajectory and takes 1.5 s to reach home plate (Wu & Gervais, 2006, 2008). Since how the ball is pitched and the amount of time that it takes to reach home plate in slo-pitch is quite different for baseball and fast pitch, the bat swing time in slo-pitch may be different from baseball and fast pitch. Interestingly, the bat swing time analysis from this study showed similar findings to previous studies on fast pitch softball and baseball hitting. In this study the total bat swing time among all three stride technique was found to be 0.586 ± 0.144 s, and this finding was the similar to Welch, Banks, Cook, and Draovitch (1995)'s baseball bat swing time of 0.570 s and Messier and Owen (1984)'s fast pitch softball bat swing time of 0.600 s. Additionally, it was observed that the maximum linear and angular bat velocities were reached at 0.024 s prior to ball contact, and this finding was same as a previous research study conducted by Spragg and Noble (1987) on female fast pitch softball hitting and male baseball hitting. Messier and Own (1982) reported that the maximum linear bat velocity was reached at 0.026 s prior to ball contact and concluded that in a sporting skill in which a striking implement is used, the striking implement rarely reaches its maximum linear velocity at impact. Further, in a previous study conducted by Wu, Gervais, Baudin, and Bouffard (2011), the authors indicated that there was no significant difference in the angular bat velocity between open, parallel and closed stride technique in slo-pitch hitting. The only statistical significant difference was observed in the linear bat velocity between the open and parallel stride techniques, so it could not be concluded as to which stride would be more advantageous to use. From the results of this study no statistical difference was found in all three stride techniques in the bat swing time; therefore, it can be further argued that using one particularly stride technique may not be more advantageous than another. In other words, all three stride techniques are similarly effective, and the batter may use whatever is most comfortable for them to strike the ball successfully. Several important research questions remain to be answered such as the influence of pitched ball location and ball field placement in relation to stride technique on the bat swing time. These findings will provide further insights into our understanding of the mechanics of slo-pitch hitting.

CONCLUSION: In this study the bat swing time between open, parallel and closed stride techniques in slo-pitch hitting were examined, and the results did not show any significant difference between all three stride techniques. Hence, this study suggests that slo-pitch batters may use all three stride techniques to strike the ball effectively. Also, in this study the slo-pitch bat swing time was found to be similar to fast pitch softball and baseball. The maximum linear and angular velocities were reached prior to ball contact, which supports the finding that in a sporting skill in which an implement used, the striking implement does not reach its maximum linear velocity at impact. Future research studies are warranted to examine the the individual and combined influence of pitched ball locations and ball field placement locations on bat swing time.

REFERENCES:

Escamilla, R. F., Fleisig, G. S., Zheng, N., Barrentine, S. W. & Andrews, J.R. (2001). Kinematic comparisons of 1996 Olympic baseball pitchers. *Journal of Sports Sciences, 19,* 665-676.

Hames, B. (1975). The swing is the thing. Athletic Journal, 55(6), 98-99.

Hay, J. G. (1978). The biomechanics of sports techniques. Englewood Cliffs: Prentice-Hall.

Koike, S., Kimura, H., Kawamura, T., Fujii, N., Takahashi, K., & Ae, M. (2003). Kinetics of the upper extremities during baseball batting. *Proceedings of 19th International Society of Biomechanics* (p. 212). Otago, New Zealand: International Society of Biomechanics.

Lopiano, D. A. (1978). Developing the hitter. *Coaching: Women's Athletics, 4*, 58-64, 92-93.

Messier, S. P. (1982). *Relationships among selected kinetic parameters, bat velocities, and three methods of striding by female softball batters.* Unpublished doctoral dissertation. Temple University, Philadelphia.

Messier, S. P., & Owen, M. G. (1984). Bat dynamics of female fast pitch softball batters. *Research Quarterly for Exercise and Sport, 55*(2), 141-145.

Messier, S. P., & Owen, M. G. (1985). The mechanics of batting: analysis of ground reaction forces and selected lower extremity kinematics. Research Quarterly for Exercise and Sport, 56(2), 138-143.

Messier, S. P., & Owen, M.G. (1986). Mechanics of batting: effect of stride technique on ground reaction forces and bat velocities. Research Quarterly for Exercise and Sport, 57(4), 329-333.

Oliver, G. D. (2003). The kinematics of the windmill softball pitch.Unpublished doctoral dissertation, Texas Women University, Denton.

Shapiro, R. (1979). *Three-dimensional kinetic analysis of the baseball swing.* Unpublished doctoral dissertation, University of Illinois, Urbana-Champaign.

Spragg, C., & Noble, L. (1987). A comparison of selected kinematic factors in male baseball and female fast pitch softball batting Alexandria, Va.: Computer Microfilms International.

Welch, C. M., Banks, S. A., Cook, F. F., & Draovitch, P. (1995). Hitting a baseball: a biomechanical description. *Journal of Orthopaedic and Sports Physical Therapy, 22*(5), 193-201.

Williams, T. S. & Underwood, J. (1968). Hitting was my life: part V-the science of batting. *Sports Illustrated, 29,* 32-45.

Wu, T., & Gervais, P. (2006). The effects of spin on ball trajectories in slo-pitch. *XIVth Biennial Conference for the Canadian Society of Biomechanics* (p. 125). Waterloo: Canadian Society of Biomechanics.

Wu, T., & Gervais, P. (2008). An examination of slo-pitch pitching trajectories. *Sports Biomechanics, 7*(1), 88-99.

Wu, T., Gervais, P., Baudin, P., & Bouffard, M. (2011). The effects of stride technique and pitch location on slo-pitch batting. *Sports Biomechanics, 10*(4), 351-360.

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