AN EXAMINATION OF SOFTBALL SLO-PITCH: EFFECTS OF SPIN ON BALL TRAJECTORY

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Introduction
Most studies have examined movement skills or strategies in baseball or fast-pitch softball. Few studies have looked at slo-pitch softball specifically. Some researchers believe that in slo-pitch, a ball is thrown in a parabola arc due to the influence of gravitational force only (Simonian, Fundamental of Sports Biomechanics, 1981). The effect of air resistance on the ball in flight is considered to be minimal. However, Dowel et al. (J. of Hum. Mov. Studies, 11: 209-221, 1985) pointed out that when the ball in flight is affected by air resistance, it actually travels in a skewed curve path. When a non-smooth and asymmetrical ball is thrown in the air, it experiences lift, drag and cross-sectional forces (Alaways and Hubbard, J. of Sports Sciences, 19: 349-358, 2001). Many slo-pitch coaches and players believe that generating the spin on the ball can affect its trajectory even if the ball is thrown with such slow speed. Nevertheless, the effect of air resistance on the ball trajectory in underhanded pitching remains unanswered, especially the correlation relationship between horizontal distance and different types of ball spin.

Objective
The purpose of this study was to examine the influence of spin in slo-pitch pitching. This experiment’s aim was to determine whether or not the angular velocity along with any potential influences from air resistance could result in a change in the horizontal displacement of the ball. It was hypothesized that when a ball was thrown underhanded in an arc with top spin, the ball would fall shorter due to the Magnus effect and would have a greater range with back spin.

Design
Quasi-experimental design.

Setting
University of Alberta, Edmonton.

Subjects
The subjects (n = 11 males and 3 females) were recruited from local division A or B slo-pitch leagues. This study was approved by a University Research Ethics Board.

Intervention/Main Outcome Measures
Each subject stood on a pitching plate that was 15.2 m (50 ft) away from an indoor home plate with an extension strike zone mat. Subjects were asked to throw five top spin pitches and five back spin pitches. Each pitch was considered successful if the ball was thrown with a moderate speed and landed on the extension strike zone mat with an arc of between 1.83 m (6 ft) and 3.66 m (12 ft). The speed, height, and location of the ball were subjectively monitored by an experienced slo-pitch player/experimenter in the same manner as in a real game situation with an umpire. If a pitch was thrown unsuccessfully, the subject was asked to repeat that particular pitch. The subject had at least 30 seconds rest between each pitch and 1 min rest between each type of pitch. Each subject’s involvement in the study was limited to one data collection session, approximately 1.5 hours in length. Twelve “Approved by Softball Canada” Dudley Spal-
ding synthetic Thunder Heat 0.30 m (12”) optic with C.O.R. 47 balls were used. Balls were marked, with a black marker, to divide them into four equal quadrants to monitor ball spin. Video of the pitches was collected using standard three-dimensional videography using 5 digital video cameras operating at 60 Hz with shutter speed set between 1/250s to 1/1000s. The first, second and third cameras were positioned at approximately 60° apart to each other to capture the release of the ball in sagittal and frontal views. The fourth camera was positioned perpendicular to the pitching motion to allow a close-up sagittal view of ball spin. The fifth camera was positioned perpendicular to the sagittal view of the home plate and strike zone extension mat to capture the landing location of the ball.

Main Results
A paired sample t-test was conducted between the top spin and the back spin variables. The horizontal and vertical velocities in the back spin were significantly higher than in the top spin. The angular velocity of the back spin was found to be 65.0 ± 2.7 rad/s, which is also significantly higher than the top spin of 42.3 ± 3.4 rad/s. The throwing distance of the back spin (14.8 ± 0.4 m) was significant further than the top spin (14.5 ± 0.4 m). No significant difference was found in the stride length used in these two pitching techniques.

Conclusions
The results from the experiment suggest that the air resistance had an influence on the ball’s trajectory even if the ball was thrown in the range of 6.0 to 10.0 m/s in the horizontal and vertical velocities. The back spin pitches projected 0.30m further than the top spin pitches in the horizontal distance. In order to determine the exact magnitude of air resistance to the ball, future studies will require the use of a wind tunnel and a ball flight simulation.

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Commentary
When a ball is thrown with spin, it creates a high velocity and low pressure area on one side of the ball and a low velocity and high pressure area on the other side of the ball. These pressure differences result in a lift force on the ball directed from the high to the low pressure region. This is known as the Magnus effect. Hence, when a ball is thrown with a top spin, the ball will travel shorter distance than a ball that is thrown with a back spin. In this experiment, when a ball was thrown with a back spin, it had higher horizontal and vertical velocities and greater angular velocity. Therefore the ball had a higher skewed arc trajectory and a longer horizontal distance. The result of longer horizontal distance may simply be due to throwing the ball with higher horizontal and vertical velocities. Whether or not spin alone is sufficient to influence the trajectory, will require the use of wind tunnel testing to determine the coefficient of lift and drag forces. This information can then be used in a flight simulation to predict its precise landing location.