



## **No Effect of Assisted Hip Rotation on Bat Velocity**

MICHELLE RIVERA\*, WHITNEY D. LEYVA\*, DAVID C. ARCHER\*, CAMERON N. MUNGER\*, CASEY M. WATKINS\* MEGAN A. WONG\*, IAN J. DOBBS\*, ANDREW J. GALPIN‡, JARED W. COBURN‡, and LEE E. BROWN‡

Human Performance Laboratory, Center for Sport Performance, Department of Kinesiology, California State University, Fullerton, CA, USA

\*Denotes undergraduate student author, ‡Denotes professional author

---

### ABSTRACT

*International Journal of Exercise Science 11(4): 68-74, 2018.* Softball and baseball are games that require multiple skill sets such as throwing, hitting and fielding. Players spend a copious amount of time in batting practice in order to be successful hitters. Variables commonly associated with successful hitting include bat velocity and torso rotation. The concept of overspeed bodyweight assistance (BWA) has shown increases in vertical jump and sprint times, but not hip rotation and batting. The purpose of this study was to examine the effects of assisted hip rotation on bat velocity. Twenty-one male and female recreational softball and baseball players (15 males, age  $23.8 \pm 3.1$  yrs; height  $177.67 \pm 6.71$  cm; body mass  $85.38 \pm 14.83$  kg; 6 females, age  $21.5 \pm 2.1$  yrs; height  $162.20 \pm 9.82$  cm; body mass  $60.28 \pm 9.72$  kg) volunteered to participate. Four different BWA conditions (0%, 10%, 20%, and 30%) were randomly applied and their effects on bat velocity were analyzed. Subjects performed three maximal effort swings under each condition in a custom measurement device and average bat velocity (MPH) was used for analysis. A mixed factor ANOVA revealed no interaction ( $p=0.841$ ) or main effect for condition, but there was a main effect for sex where males had greater bat velocity ( $43.82 \pm 4.40$  - 0% BWA,  $41.52 \pm 6.09$  - 10% BWA,  $42.59 \pm 7.24$  - 20% BWA,  $42.69 \pm 6.42$  - 30% BWA) than females ( $32.57 \pm 5.33$  - 0% BWA,  $31.69 \pm 3.40$  - 10% BWA,  $32.43 \pm 5.06$  - 20% BWA,  $32.08 \pm 4.83$  - 30% BWA) across all conditions. Using the concept of overspeed training with assisted hip rotation up to 30% BWA did not result in an increase in bat velocity. Future research should examine elastic band angle and hip translation at set-up.

KEY WORDS: Elastic band, baseball, softball, speed

### INTRODUCTION

Softball is a game that requires multiple skill sets such as throwing, hitting and fielding. Each of these require dedicated time to improve performance. A skill that players tend to spend a lot of time on is batting, specifically increasing bat velocity. Successful hitting in baseball is attributed to multiple factors that include quick perception, reaction, accurate swing, and bat velocity (5, 6, 9,13, 24, 25). Not only has bat velocity been correlated with successful hitting, but torso rotation is also an important component to hitting (7,19-21, 25). Hitting involves a kinetic link (7, 19-21) which refers to batters producing force from the ground up through the legs, hips,

torso, and upper body (20). If contact with the ball in a well synced manner, the increase in bat velocity will cause the ball to travel faster and further (9, 19)

Previous research has shown that swinging with a lighter bat can increase acute bat velocity (9,14) and that torso rotation strength also helps increase bat velocity (19). Previous research examining vertical and linear elastic cord assistance have been shown to be effective at increasing acute body movement velocity (2, 24). Bartolini et al.(2) examined elastic cord assistance levels for sprinting and found that 30 percent body weight assistance (BWA) was optimal for maximum velocity in collegiate women soccer players. A similar study by Tran et al. (22, 23) examined vertical jump and also found optimal BWA to be 30 percent body weight for jump height (3,22, 23). Similar findings by Southard et al. in a 5- week training period found that assisted counter movement jumps increased jump height in male indoor volleyball players (16). Bat velocity was examined by Montoya et al. (9) and they found that warming up with a lighter bat increased acute normal bat velocity (17). Studies have also examined angular hip velocity and found an increase in bat-end velocity when incorporating speed rotational exercises (1, 20, 21).

The concept and results of these overspeed BWA studies may apply to hip rotation and bat velocity (2, 3, 9, 22, 23, 24). With previous knowledge of high velocity outcomes, there is a need to examine hip rotation as the coupling of assisted rotation and its effects on bat velocity. Therefore, the purpose of this study was to examine the effects of assisted hip rotation on bat velocity.

## METHODS

### *Participants*

21 male and female recreational softball and baseball players between the ages of 18-29 volunteered to participate (15 males, age  $23.8 \pm 3.1$  yrs; height  $177.67 \pm 6.71$  cm; body mass  $85.38 \pm 14.83$  kg; 6 females, age  $21.5 \pm 2.1$  yrs; height  $162.20 \pm 9.82$  cm; body mass  $60.28 \pm 9.72$  kg) and all subjects were right handed hitters. Recreational was defined as currently playing in a softball league or baseball league and having played for at least two years. Only position players were used, no pitchers. All procedures were approved by the University Institutional Review Board for human subjects and all participants signed an informed consent document prior to testing.

### *Protocol*

Set-Up: Participants wore a rock climbing harness that was tightened around their waist, (Black Diamond Momentum Harness) and had a carabineer attached to a loop on their right hip. Adjustments to BWA were made by two 24.5in elastic cords (Ver Sales, Burbank, CA, USA) attached to a Ronstan 40-mm Fiddle Block, Cleat, Becket, All-Purpose #RF41530 (Ronstan, Sandringham, Victoria, Australia). Elastic cord tension was determined using a crane scale (Model #ICS- CCS-500, Industrial Commercial Scales, LLC. North Charleston, SC, USA) which was placed in the same position for all visits. To adjust the amount of tension, one end was attached to a hand crank (600 lb. zinc-plated trailer winch with solid gears, Model# BR59230, Internet # 203494921). The hand crank and crane scale were positioned on a standard table, 30in

from the ground for all visits. Subjects stood in a simulated batter's box that was placed at a 140-degree angle, relative to the crane scale and elastic band, pulling sideways and rearward while facing a net (figure 1). Subjects were pulled per the randomized percentage of BWA chosen, with torso rotation while swinging. A portable aluminum custom bat velocity measurement device which consisted of 2 vertical photoelectric sensors (Model E3Z; Omron Electronics, Schaumburg, IL) separated by 45 cm (home plate) was placed in front of the batter's box. The sensors were situated so they were perpendicular to the front and rear of home plate. A softball was placed on a tee stand on home plate to simulate a real hitting situation, and subjects were required to reset their foot placement after each swing. The placement of the participants back foot was recorded in a simulated batter's box drawn around a measured home plate in the laboratory. Grid marks were made along the batter's box 1in apart. Markers were placed inside the batter's box to insure consistent foot placement after each swing and subsequent visits. All subjects swung the same bat (COMBAT TCSFP110 Fast Pitch Softball Ball aluminum bat, 34in/23oz) to break the two sensor lights sending signals to a data acquisition computer sampling at 10,000Hz. Custom LabVIEW (Version 2015; National Instruments, Austin, TX, USA) software was used to analyze the signals in miles per hour (MPH). Participants were required to wear athletic attire; gloves and other athletic gear were options but required for both visits if used.



**Figure 1.** Bat velocity device and assisted hip rotation set up.

Day 1 - Familiarization and Test Day: Body mass and height were recorded using an electronic scale (ES200L; Ohaus Corporation, Pinebrook, NJ, USA) and Electronic Stadiometer (Seca, Ontario, CA, USA). Warm up consisted of lunges with rotation and knee hugs for 10 meters followed by three warm up swings. Participants were then instructed to position themselves in the batter's box on the floor of the laboratory as they would in a real hitting situation; foot placement and tee height were recorded. Tee height was adjusted individually by each participant to their preferred height, and was recorded by markers placed at 0.5in increments and used for all subsequent visits. Participants randomly chose the order of BWA of 10, 20, or 30 percent for subsequent visits. Three practice swings were then performed to confirm they could break both photoelectric sensors while standing in the batter's box and hitting off the tee. After 2 min rest, they performed 3 maximal bat swings to establish baseline bat velocity at 0% BWA. Participants then performed an assisted practice swing of the randomized BWA condition for that day to familiarize them with the elastic band pull. Finally, participants performed their first condition with 3 maximal effort BWA swings. The subsequent test session was separated by 24 to 48 hours.

Day 2 - Final Test Day: Upon arrival, participants completed the same warm-up protocol as day 1. Subjects then performed 3 practice swings with no assistance and then the remaining two randomized BWA conditions.

*Statistical Analysis*

A 2x4 (sex x condition) mixed factor analysis of variance (ANOVA) was performed to determine differences in bat velocity. Alpha was set a-priori at 0.05. All statistical analyses were performed using IBM SPSS Statistics software (version 24, IBM, Armonk, NY, USA).

**RESULTS**

Men were taller (P=0.001) and heavier (P=0.001) than women but age was not different (P=0.130). There was no interaction (p=0.841) or main effect for condition, but there was a main effect for sex where males had greater bat velocity than females across all conditions (Table 1).

**Table 1.** Means ± standard deviations of bat velocity (MPH) across sex and body weight assistance (BWA) conditions.

	Male	Female
0% BWA	43.82±4.40*	32.57±5.33
10% BWA	41.52±6.09*	31.69±3.40
20% BWA	42.59±7.24*	32.43±5.06
30% BWA	42.69±6.42*	32.08±4.83

\*Significantly greater than females.

**DISCUSSION**

The purpose of this study was to examine the effects of assisted hip rotation on bat velocity. Our results demonstrated no difference between baseline bat velocity and any assisted hip rotation condition. Possible reasons for no effects may be due to altered hitting mechanics via the BWA,

assisted conditions may have been too much or at a less than optimal angle, thereby resulting in hip translation rather than rotation.

While the present study did not find any improvement in performance with assisted hip rotation, previous studies utilizing overspeed and assistance have shown positive results. Bartolini et al. examined overspeed with elastic cord assistance at 10, 20, 30, and 40% BWA. They concluded that 30% assistance was optimal for assisted sprinting (2). In a similar study using the findings from Bartolini et al, Nealer et al. (12) used 30% BWA to examine the influence of rest times and postactivation potentiation on subsequent unassisted sprinting. Their subjects performed sprints with randomized rest times of 30s, 1min, 2min, or 4 min and they found that sprint speed was increased with elastic band assistance and at rest times between 1min and 2min significantly decreased bodyweight sprint times in collegiate soccer players. Similarly, Tran et al. (23) examined elastic cord assisted jumping with 10, 20, 30, and 40% BWA and found that jump height and take off velocity increased up to 40%. Unlike these previous studies, the current study did not show improvements in bat velocity with assisted hip rotation. This may have been due to the elastic band providing trunk translation, not hip rotation. While participants were instructed to remain stationary, the elastic band tension may have caused a combination of translation and rotation rather than just rotation, thus negating any bat velocity increases.

Another possibility for no changes in bat velocity in the current study may have been too much assistance, potentially causing the bat to lag. Fleisig et al. examined trunk axial rotation and angular acceleration in elite pitchers and batters in order to quantify trunk axial rotation and angular acceleration in batting. They separated batting into different phases: stance, stride, drive, bat acceleration, and follow through (4). They found that during the stance phase the batter shifted their weight toward the back foot, and ended when the front foot was lifted off the ground (4, 8,11). During the drive phase, the pelvis and then the upper trunk rotated and the lag between the two equated to trunk axial rotation and maximum angular acceleration. Maximum bat lag to bat-ball contact was during the acceleration phase, where the pelvis and the upper trunk rotated to face the pitcher (4). In the present study, the applied assistance may have altered the shift toward the back foot causing timing to be delayed when shifting toward the front foot. Therefore, alterations caused by the BWA may have affected the stride phase. While participants were asked to remain stationary during the BWA conditions, the elastic band may have altered their stride phase when the front foot was lifted causing the back foot to compensate in order to maintain balance. Trunk axial rotation was computed by Fleisig et al. as the angle between the pelvis and the upper trunk in the transverse plane. Before a batter made contact with the ball, maximum axial rotation was  $\sim 19^\circ$  and after ball contact, maximal axial rotation was  $\sim 46^\circ$  (4). We did not measure these in the present study, as they only confirm trunk rotation. In the present study, angle of the elastic assistance in relationship to the batters box was  $140^\circ$ , which may have altered swing mechanics, thus causing translation or increased rotation time. The angle of the band was determined by the batter's box and the crank. This band angle may have altered the participant's normal hip and trunk angle during body weight assistance which may have affected their normal swing pattern. We chose this angle to try and promote hip rotation rather than hip translation. Optimal elastic band angle during swinging has yet to be investigated.

In a study conducted by Reyes et al., they investigated the effects of whole-body vibration and exercise order on bat velocity, as well as the relationship between strength and bat velocity (15). Participants were tested for their one repetition maximum in a squat and bench press prior to bat velocity testing. Their results revealed a relationship between lower body strength and bat velocity but not upper body strength (15). This is similar to previous research where rotation forces produced in the lower body help generate maximal bat velocity (7, 10, 15, 18, 19, 20). If a hitter has inadequate strength and transfer from their back to front foot, a loss in bat velocity may occur (15). Although the present study did not examine strength, the BWA applied during each condition may have altered load transfer from the back to front foot. Therefore, this may have caused the batter to adjust their swing pattern or body position to complete a successful swing which may explain why there was no change in bat velocity.

Although BWA has previously been shown to increase both vertical jump height and sprint times, there is a lack of information on assisted hip rotation and bat velocity. In the present study with recreational softball and baseball players, assisted hip rotation failed to show increases in bat velocity. Therefore, future research should investigate different levels of BWA on hip rotation and translation that may potentially increase bat velocity.

## REFERENCES

1. Adair RK. The physics of baseball. New York: HarperPerennial, 1994.
2. Bartolini JA, Brown LE, Coburn JW, Judelson DA, Spiering BA, Aguirre NW, Carney KR, Harris KB. Optimal elastic cord assistance for sprinting in collegiate women soccer players. *J Strength Cond Res* 25: 1263-1270, 2011.
3. Cazas VL, Brown LE, Coburn JW, Galpin AJ, Tufano JJ, LaPorta JW, Du Bois AM. Influence of rest intervals after assisted jumping on bodyweight vertical jump performance. *J Strength Cond Res* 27: 64-68, 2013.
4. Fleisig GS, Hsu WK, Fortenbaugh D, Cordover A, Press JM. Trunk axial rotation in baseball pitching and batting. *Sports Biomech* 12: 324-333, 2013.
5. Higuchi T, Morohoshi J, Nagami T, Nakata H, Kanosue K. The effect of fastball backspin rate on baseball hitting accuracy. *J Appl Biomech* 29: 279-284, 2013.
6. Hughes SS, Lyons BC, Mayo JJ. Effect of grip strength and grip strengthening exercises on instantaneous bat velocity of collegiate baseball players. *J Strength Cond Res* 18: 298-301, 2004.
7. Iino Y, Fukushima A, Kojima T. Pelvic rotation torque during fast-pitch softball hitting under three ball height conditions. *J Appl Biomech* 30: 563-573, 2014.
8. Katsumata H. A functional modulation for timing a movement: A coordinative structure in baseball hitting. *Hum Mov Sci* 26: 27-47, 2007.
9. Montoya BS, Brown LE, Coburn JW, Zinder SM. Effect of warm-up with different weighted bats on normal baseball bat velocity. *J Strength Cond Res* 23: 1566-1569, 2009.
10. Myers J, Lephart S, Tsai YS, Sell T, Smoliga J, Jolly J. The role of upper torso and pelvis rotation in driving performance during the golf swing. *J Sports Sci* 26: 181-188, 2008.

11. Nakata H, Miura A, Yoshie M, Kanosue K, Kudo K. Electromyographic analysis of lower limbs during baseball batting. *J Strength and Cond Res* 27: 1179-1187, 2013.
12. Nealer AL, Dunnick DD, Malyszek KK, Wong MA, Costa PB, Coburn JW, Brown LE. Influence of rest intervals following assisted sprinting on bodyweight sprint times in female collegiate soccer players. *J Strength Cond Res* 31(1): 88-94, 2017.
13. Otsuji T, Abe M, Kinoshita H. After-effects of using a weighted bat on subsequent swing velocity and batters' perceptions of swing velocity and heaviness. *Percept and Mot Skills* 94: 119-126, 2002.
14. Reyes C, Browder K, Dolny D. Acute effects of various weighted bat warm-up protocols on baseball bat velocity. *Med Sci Sports Exerc* 38: S245-S245, 2006.
15. Reyes GFC, Dickin DC, Dolny DG, Crusat NJK. Effects of muscular strength, exercise order, and acute whole-body vibration exposure on bat swing speed. *J Strength Cond Res* 24: 3234-3240, 2010.
16. Sheppard JM, Dingley AA, Janssen I, Spratford W, Chapman DW, Newton RU. The effect of assisted jumping on vertical jump height in high-performance volleyball players. *J Sci Med Sport* 14: 85-89, 2011.
17. Southard D, Groomer L. Warm-up with baseball bats of varying moments of inertia: Effect on bat velocity and swing pattern. *Res Q Excer Sport* 74: 270-276, 2003.
18. Stodden DF, Fleisig GS, McLean SP, Lyman SL, Andrews JR. Relationship of pelvis and upper torso kinematics to pitched baseball velocity. *J Appl Biomec* 17: 164-172, 2001.
19. Szymanski DJ, McIntyre JS, Szymanski JM, Bradford TJ, Schade RL, Madsen NH, Pascoe DD. Effect of torso rotational strength on angular hip, angular shoulder, and linear bat velocities of high school baseball players. *J Strength Cond Res* 21: 1117-1125, 2007.
20. Szymanski DJ, Szymanski JM, Bradford TJ, Schade RL, Pascoe DD. Effect of twelve weeks of medicine ball training on high school baseball players. *J Strength Cond Res* 21: 894-901, 2007.
21. Szymanski DJ, Szymanski JM, Schade RL, Bradford TJ, McIntyre JS, DeRenne C, Madsen NH. The relation between anthropometric and physiological variables and bat velocity of high-school baseball players before and after 12 weeks of training. *J Strength Cond Res* 24: 2933-2943, 2010.
22. Tran TT, Brown LE, Coburn JW, Lynn SK, Dabbs NC. Effects of assisted jumping on vertical jump parameters. *Curr Sports Med Rep* 11: 155-159, 2012.
23. Tran TT, Brown LE, Coburn JW, Lynn SK, Dabbs NC, Schick MK, Schick EE, Khamoui AV, Uribe BP, Noffal GJ. Effects of different elastic cord assistance levels on vertical jump. *J Strength Cond Res* 25: 3472-3478, 2011.
24. Upton DE. The effect of assisted and resisted sprint training on acceleration and velocity in division ia female soccer athletes. *J Strength Cond Res* 25: 2645-2652, 2011.
25. Wilson JM, Miller AL, Szymanski DJ, Duncan NM, Andersen JC, Alcantara ZG, Morrison TJ, Bergman CJ. Effects of various warm-up devices and rest period lengths on batting velocity and acceleration of intercollegiate baseball players. *J Strength Cond Res* 26: 2317-2323, 2012.

