



## **The Effects of Medicine Ball Training on Bat Swing Velocity in Prepubescent Softball Players**

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### ABSTRACT

*International Journal of Exercise Science 11(4): 75-83, 2018.* The purpose of this study was to assess the effects of an 8-week medicine ball training program on bat swing velocity in prepubescent softball players. Twenty-seven female prepubescent softball players (age =  $10.2 \pm 1.2$ ) participated in this study. Participants were randomly assigned to either a medicine ball training ( $MB = 13$ ) or control ( $CON = 14$ ) group. Pre- and post-testing consisted of 10 dry swings using the bat that the participants would normally use during competition, which was then followed by 10 hits off of a pitching machine with bat swing velocity being measured with each swing. During the 8 weeks of training, the  $MB$  group completed sport-specific medicine ball throws that were aimed at developing rotational velocity. Exercises included side medicine ball throws, Russian twists, woodchoppers, and standing band rotations. Participants that were 8-10 years old used a 4-lb medicine ball while 11-13 year olds used a 6-lb medicine ball during all exercises. Participants completed 1 set of 12 repetitions 2x/wk. There were no significant interaction effects ( $F = 1.91, p = 0.18$ ) between both conditions ( $MB$  and  $CON$ ) from pre- to post-testing for average bat swing velocity. Average bat swing velocity from pre- to post-testing for the  $MB$  group was  $35.93 \pm 6.66$  miles-hour<sup>-1</sup> and  $38.22 \pm 8.63$  miles-hour<sup>-1</sup>, respectively. Average bat swing velocity from pre- to post-testing for the  $CON$  group was  $36.07 \pm 5.92$  miles-hour<sup>-1</sup> and  $37.71 \pm 4.42$  miles-hour<sup>-1</sup>, respectively. Overall, there was a 6.37% and 4.55% increase in bat swing velocity from pre- to post-testing for the  $MB$  and  $CON$  groups, respectively. Therefore, medicine ball training offers no additional benefits in bat swing velocity.

**KEY WORDS:** Softball, bat swing velocity, medicine ball training, prepubescent, rotational exercises, sport-specific

### INTRODUCTION

One of the major sport skills associated with softball is hitting, which involves explosive, rotational movements. When hitting is executed properly, kinetic energy is transferred in a sequential manner from the lower extremity through the torso to the upper extremities, which allows for maximal bat speed (12). In order to transfer forces generated from the lower body to the upper body while hitting, softball players need sufficient hip and torso rotational

strength (29). An important factor that affects rotational strength, therefore also affecting bat speed, is a physiological concept known as the stretch-shortening cycle (SSC). The SSC involves an active stretch (i.e., eccentric contraction) of a muscle followed by an immediate shortening (i.e., concentric contraction) of that same muscle (1). The SSC allows hitters to utilize stored elastic energy along with neural stimulation of the muscles in a sequential order to swing the bat with increased speed (1). There are also numerous sport-specific resistance training protocols implemented by athletes and coaches aimed at improving bat speed by developing explosive, rotational movements (4, 12, 29). Findings from research studies that have implemented these sport-specific resistance training protocols (e.g., weighted implement warm-ups, weighted bat training, or full-body resistance training) have all for the most part been in agreement and have been shown to improve bat speed (6, 7, 8, 9, 10, 11, 18, 24, 26, 28, 29, 30).

Sport-specific resistance warm-ups utilizing weighted implements (e.g., the commercial donut ring and power tubes and sleeves) have been found to improve bat speed in high school, collegiate, and ex-collegiate baseball players (6, 7, 8, 10, 18, 26). DeRenne and colleagues (6, 7, 8, 10), Montoya and colleagues (18), and Southard and Groomer (26) demonstrated that when performing an on-deck warm-up with weighted implements that were 1.5-4 oz. heavier than the standard bat weight significantly reduced bat speed by 5 miles·hour<sup>-1</sup> and changed swing mechanics. In addition, performing weighted bat implement training, which is conducted over a period of several weeks has also been found to improve bat speed in baseball players (9, 11, 24). DeRenne and colleagues (9, 11) and Sergo and Boatwright (24) demonstrated significant increases in bat speed when implementing protocols that consisted of swinging wooden bats 34-62 oz. (12-100% greater than the standard bat weight) 240-300 times per week for a duration of 6-7 weeks.

Finally, full-body resistance training and sport-specific programs utilizing medicine ball exercises have also been found to significantly improve bat speed (28, 29, 30). The effects that medicine ball training has on children and their health and/or sport performance are limited, especially in the area of softball training. However, medicine ball training in children is initially often recommended as a form of resistance training because it has been found to be safer to perform resulting in fewer injuries as when compared to other forms of resistance training such as free weights and plyometrics, and develops the neuromusculature for more advanced training in free weights and plyometrics (1). In addition, Ikeda and colleagues (17) recommend medicine ball training as an appropriate mode of exercise for improving power development because there is no deceleration phase at the end of the concentric movement in many medicine ball exercises, which is similar to many sports movements such as hitting. Additionally, medicine ball training also allows baseball players to mimic the powerful, sequential, and rotational actions that are observed while hitting a baseball, therefore, allowing a hitter to swing a bat with greater velocity. Faigenbaum and Mediate (14) and Szymanski and colleagues (30) demonstrated that a progressive, periodized medicine ball training program in combination with either physical education classes or full-body resistance training to be beneficial for enhancing bat speed in high school baseball players. However, when Szymanski and colleagues (28) implemented a similar protocol in collegiate baseball players, bat speed

did not improve. Szymanski and colleagues (28) suggested that these differences seen in bat speed between high school and collegiate baseball players could possibly be due to the collegiate baseball players already having an established strength base, and since the high school baseball players were initially on average much weaker when starting the resistance training program any improvements in strength would improve bat speed (28).

The need to improve both physical fitness and sport performance in children has prompted the development of new and creative approaches that provide the opportunity for all boys and girls to participate in regular, healthful physical activity, exercise, and/or sports. Since an abundant amount of data already exists that has examined the effects of various training programs on bat speed in baseball players, it is imperative to examine the effects of these various training programs on bat speed in softball players, more specifically prepubescent softball players. Thus, the purpose of this study was to assess the effect of medicine ball training on bat swing velocity in prepubescent softball players. This study utilized a between-subjects design to compare the average bat swing velocity between two conditions: medicine ball training (*MB*) and control (*CON*). It was hypothesized that bat swing velocity would increase after completing 8-weeks of medicine ball training. This was hypothesized as medicine ball training has been previously shown to increase bat swing velocity (28, 30). To the best of our knowledge, this is the first study to utilize and examine specific medicine ball exercises to improve bat swing velocity in prepubescent softball players.

**METHODS**

*Participants*

Twenty-seven female prepubescent softball players between the ages of 8-13 years old (10.2 ± 1.2 years, Table 1) with at least 1-year of softball experience were recruited to participate in this study. All participants were recruited from only recreational teams in the Northeast Ohio region. Participants were excluded if they had any contraindications to exercise (i.e., orthopedic injuries, cardiovascular disorders). Prior to participation participants and parents were instructed on the benefits and risks of the study and signed child informed assent, adult informed consent, and medical history forms. This study was approved by The University of Akron Institutional Review Board.

**Table 1.** Average height, weight, and age.

	<i>N</i> = 27
Height (cm)	142.38 ± 13.18 cm
Weight (kg)	37.6 ± 11.5 kg
Age (years)	10.2 ± 1.2 years

All data are means ± SD

*Protocol*

Participants reported to an outdoor batting cage located in Northeast Ohio for pre-testing. During pre-testing participants completed a warm-up that consisted of 10 dry swings using the bat that they normally would use during competition. Immediately following their warm-up, participants hit 10 pitches off the JUGS Super Softball Pitching Machine (Tualatin, Oregon)

with the same bat that they previously used during the warm-up (18, 19) (NOTE: pitches that participants did not swing at did not count). The principal investigator operated the pitching machine and all pitches to the participants were fastballs within the strike zone. The speed of the pitches from the pitching machine was determined based off of the age of the participants. The speed of each pitch for participants between the ages of 8-10 years was 40 miles·hour<sup>-1</sup>, while for participants between the ages of 11-13 years was 50 miles·hour<sup>-1</sup> (25). These pitch speeds were selected because during a 10u fast pitch league pitchers throw a fastball between 38-42 miles·hour<sup>-1</sup> and in 12u leagues pitchers throw a fastball between 46-52 miles·hour<sup>-1</sup>. These pitch speeds have also been used in previous studies (25). The bat swing velocities (miles·hour<sup>-1</sup>) of all 10 bat swings were recorded for each participant. Bat swing velocity was measured with a Swing Speed Radar Measurement Device (Sports Sensors, Inc., Cincinnati, OH). The device was placed two feet in front of the opposite batter's box and then two feet outside of that batter's box. This placement of the device allowed for bat swing velocity to be assessed as the bat made contact with the ball. The results of all 10 bat swings were then averaged. During the 10 bat swings, each participant was instructed to not look at their bat swing speeds as this may have caused them to become distracted and/or frustrated.

After pre-testing was completed all participants were randomly assigned to either a medicine ball training (*MB* = 13) or control (*CON* = 14) group. The participants that were randomly assigned to the *MB* group completed 8-weeks of medicine ball training that consisted of 4 medicine ball throws that were aimed at developing rotational velocity (28, 30). The medicine ball throws included side medicine ball throws for distance, speed, and accuracy, Russian twists, woodchoppers, and standing side band rotations. All exercises were done on both dominant and non-dominant sides. Previous studies that have incorporated these medicine ball exercises deemed them to be appropriate for improving rotational velocity (17, 28, 30). Participants between the ages of 8-10 years used a 1.82-kg medicine ball while the participants between the ages of 11-13 years used a 2.73-kg medicine ball. Participants completed two sets of 12 repetitions of all medicine ball exercises, with 30-seconds of rest between each exercise, 2 days per week, for 8-weeks. According to the American College of Sports Medicine (ACSM), children and adolescents should perform 8-15 repetitions of an exercise to the point of moderate fatigue with good mechanical form at least two days per week (22). The National Strength and Conditioning Association (NSCA) also suggests that rest period between sets for children and adolescents to be  $\leq 30$  seconds (1). All sessions were supervised by the principal investigator and research personnel. During all sessions the principal investigator discussed and demonstrated proper medicine ball training procedures, and the participants had the opportunity to ask questions. In addition, all participants in the *MB* group attended an introductory training session before the initiation of the 8-weeks of medicine ball training because none of the participants had prior medicine ball training experience. During this time, the participants were taught the proper technique of each medicine ball exercise and any questions they had were answered. The participants in the *CON* group were instructed to continue their normal daily activities and to avoid any medicine ball exercises that were included in this study. After the 8-weeks of medicine ball training were completed, participants completed post-testing which utilized the same protocol as pre-testing.

### Statistical Analysis

All data were analyzed with SPSS version 22.0 (SPSS Incorporated, Chicago, IL) with a-priori  $\alpha$  level of  $\leq 0.05$ . A two (pre- and post-testing, a within factor)  $\times$  two (*MB* and *CON*, a between factor) factorial ANOVA was utilized to examine differences in average bat swing velocity. When appropriate, post-hoc analysis for all significant main effects were completed using t-tests with the Benjamini and Hochberg False Discovery Rate correction (2).

## RESULTS

Average bat swing velocity: There were no significant interaction effects ( $F_{1,25} = 1.91, p = 0.18$ ) between both conditions (*MB* and *CON*) from pre- to post-testing for average bat swing velocity (Table 2). Average bat swing velocity from pre- to post-testing for the *MB* group was  $35.93 \pm 6.66$  miles·hour<sup>-1</sup> and  $38.22 \pm 8.63$  miles·hour<sup>-1</sup>, respectively. Average bat swing velocity from pre- to post-testing for the *CON* group was  $36.07 \pm 5.92$  miles·hour<sup>-1</sup> and  $37.71 \pm 4.42$  miles·hour<sup>-1</sup>, respectively. In the *MB* group, bat swing velocity improved for 8 subjects and declined for 5, while in the *CON* group 7 subjects improved and 7 declined. Overall, there was a 6.37% and 4.55% improvement in bat swing velocity from pre- to post-testing for the *MB* and *CON* groups, respectively.

**Table 2.** ANOVA summary table.

Source	df	F	p
Group	1	0.33	0.57
Time	1	2.02	0.17
Group $\times$ Time	3	1.91	0.18

## DISCUSSION

This study utilized a between-subjects design to compare the average bat swing velocity between two conditions (*MB* and *CON*). More specifically, this designed allowed us to assess a common sport-specific resistance training technique (e.g., medicine ball training) in prepubescent softball players to observe if it had any effects on bat speed. Previous research has focused immensely on training programs aimed at improving bat speed in high school and collegiate baseball players. Such training programs have implemented sport-specific resistance training protocols (e.g., weighted implement warm-ups, weighted bat training, or full-body resistance training) and have demonstrated favorable results at improving bat speed (6, 7, 8, 9, 10, 11, 18, 24, 26, 28, 29, 30).

The present results demonstrated that average bat swing velocity was not different between the *MB* and *CON* conditions. This was not an expected outcome as previous research has demonstrated medicine ball training to improve bat speed, however, this finding was only observed in male high school baseball players (30). Szymanski and colleagues (29) conducted a similar study in collegiate baseball players and did not find significant improvements in bat speed. Szymanski and colleagues (29) suggested that no significant improvements were seen in the collegiate baseball players due to already having an established strength base. One would think that since prepubescents have low levels of muscular strength that an 8-week

medicine ball training program would have beneficial effects on their bat speed, however, according to Baechle and Earle (1) most gains in muscular strength for children are due to neurological improvements rather than muscular strength adaptations. This may help explain why participants in the current study did not have improvements in their bat speed. However, there is still room for doubt because Faigenbaum and colleagues demonstrated a variety of training protocols and modalities to be effective at increasing muscular fitness in children (15). Another reason why significant improvements in bat speed may have not been observed is because the medicine ball exercises used in the current study only focused on rotational movements. According to Oliver and colleagues (21), hitting is a full kinetic chain activity that involves the sequential contraction of muscles associated with the lower extremity, torso, and upper extremities. With that being said, Oliver and colleagues (21) suggest that training for prepubescents should follow a segmental progression from proximal to distal that includes the lower and upper extremities and the torso. The medicine balls that were included in the current study focused mostly on the torso and did not include the lower and upper extremities to a great extent. Of most importance and most likely why significant findings were not observed in the current study was because during the 8-week medicine ball training program there was no progression. Medicine ball training studies conducted by Szymanski and colleagues (30) and Faigenbaum and Mediate (26) have incorporated a progressive increase in the intensity of the exercises that were performed (i.e., increase in resistance and decrease in repetitions). According to DeLorme (5) and Berger (3), heavy resistance and low repetition protocols enhance muscular strength and power (e.g., repetition maximum [RM] resistances of 6 or less). The resistance used in the current study was medicine balls that weighed 1.82-kg for the participants that were 8-10 years old and 2.73-kg for the participants that were 11-13 years old, and all participants completed two sets of 12 repetitions for all medicine ball exercises. Three important design flaws in the medicine ball training program were that there was no progression, repetitions were not 6 or less, and the medicine ball weight was not set relative to body weight. These design flaws could be an explanation as to why no significant improvements were not seen in bat speed.

In addition to the potential implications that 8-weeks of medicine ball training may have on bat speed, these non-improvements in bat speed may have important implications for continued participation in softball. Szymanski and colleagues (28) stated that in order to become a successful hitter one must improve their bat swing velocity. It is possible that if prepubescent softball players are not successful at hitting they may lose interest in the game of softball and become disengaged. Liking or hedonics is an affective rating of a behavior that directly correlates with physical activity and/or exercise participation (13, 16, 20). Liking for an activity has been shown to be predictive of the amount of that activity an individual chooses to engage in (13, 16, 20). Therefore, it is reasonable to suggest that if a prepubescent softball player is not capable of improving their bat speed, then they may also not be successful at hitting and may be less willing to continue to engage in the game of softball. Future research should examine prepubescent softball player's hitting and liking of softball, which will offer greater insight into their behaviors. This is why it is imperative to examine the effects that different sport-specific resistance training protocols will have on prepubescent softball player's bat speed. If a protocol is found to be effective, not only will it

improve their bat speed, but it will also possibly have important implications on their performance and continued participation in physical activity, exercise, and/or sports.

While we believe this study yields novel and useful information, it is not without limitations. The sample consisted on prepubescent softball players between the ages of 8-13 years old ( $10.2 \pm 1.2$  years). Due to the wide age range, significant results may have been difficult to detect. Statistical analysis was conducted looking at separate age groups (8-10 and 11-13 years old, however, this severely reduced the sample size of each age group making the detection of significant results even more difficult. Presently we only examined only 4 medicine ball exercises. Previous studies have incorporated more than 4 medicine ball exercises in addition with other exercises or bat swings. It may be that only performing 4 medicine ball exercises was not a great enough stimulus to enhance the rotational strength of the participants. In addition, neurological adaptations are more prone in this population rather than strength and power improvements (1). Finally, there was no periodization model implemented, meaning that, the participants used the same medicine ball weight, and performed the same number of sets and repetitions for the duration of the entire 8-weeks. Previous studies have implemented a stepwise periodization model in which one starts with high volume and low intensity and progressively transitions to low volume and high intensity (30). Previous studies have also stated that the greatest improvements in bat speed have been seen when athletes perform an on-deck warm-up with implements that weigh  $\pm 12\%$  of standard bat weight (30-31 oz.) (6, 8, 10). It is a possibility that the weight of the medicine balls used during the 8-week training program were not of sufficient weight to induce any enhancements in rotational strength. Due to the range in size within each sub-group (8-10 years and 11-13 years), it may have been more appropriate to set the medicine ball weight used for each participant relative to their body weight. Future studies should focus on a more specific age range when examining the effects of a training program on children, create a stepwise periodization medicine ball training program, and compare medicine ball training to other sport-specific resistance training programs to see which one, if any, will be the most beneficial for improving bat speed. However, it should be noted that medicine ball training did not cause the participant's bat swing velocity to worsen. Medicine ball training in prepubescent children may offer additional benefits besides improving bat speed velocity, which should be explored.

Medicine ball training is a unique and essential sport-specific resistance training protocol that has been implemented to improve bat speed. Such training is research based, injury free, and enhances youth, high school, and collegiate players' bat speed (12). However, we are only just now beginning to understand how prepubescent softball players respond to these sport-specific resistance training protocols. Presently, we have demonstrated that engaging in 8-weeks of medicine ball training did not improve bat swing velocity in prepubescent softball players. However, due to medicine ball training being safe, having a decreased risk of injury associated with it, and allowing players to mimic the powerful, sequential, and rotational actions that are observed while hitting a softball, this type of training should continue to be investigated in prepubescent softball players.

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