THE EFFECTS OF A MEDICINE BALL TRAINING PROGRAM ON BAT VELOCITY OF PREPUBESCENT SOFTBALL PLAYERS

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THE EFFECTS OF A MEDICINE BALL TRAINING PROGRAM ON BAT VELOCITY OF PREPUBESCENT SOFTBALL PLAYERS

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Thesis

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CHAPTER I
INTRODUCTION

One of the major skills of softball hitting consists of explosive, rotational movements. When hitting is executed properly, kinetic energy is transferred from the lower extremity through the torso to the upper extremities, which allows for maximal bat speed (DeRenne et al. 2009). Strength and conditioning coaches seek to improve the performance of softball players’ bat speed through weighted implement training. To accomplish this goal, strength and conditioning coaches use specificity of training, which means that exercises mimic the sport skill as much as possible. Weighted implement training is a unique training protocol to enhance bat speed performances in softball players. The Soviet Union Track and Field team has also used weighted implement training for decades. They believed that under-weighted and weighted training worked for their track and field athletes. The idea behind under-weighted training was that the athletes’ body segments would move at higher speeds with less muscle force being generated because lighter implements than normal were being thrown (speed training). In contrast, over-weighted training (strength training) allowed for the athletes’ body segments to move at slower speeds with greater muscle force generated because heavier implements than normal were being performed
(DeRenne et al. 2009). Weighted implement training for softball and baseball consists of exercising with modified standard competitive bats while trying to mimic the acceleration and deceleration of the swing’s full range of motion (ROM). This becomes important because if softball players can improve their bat velocity, they will have a better chance of success at the plate. For example, if a softball player has greater bat velocity, she will be able to wait longer before deciding whether to hit the ball or not, and if she does decide to hit the ball she will be able to generate a more powerful hit \( (P = w/t) \). This could improve run production, which in turn will help the team win more games and reach the next level of competitive play.
CHAPTER II
LITERATURE REVIEW

There is much research within the realm of athletics that suggest different methods to improve bat velocity. Baseball and softball players alike can develop muscular strength by means of traditional resistance training, but the performance aspect that deserves the greatest attention is muscular power. Muscular power is defined as the “ability of a muscle tissue to exert high force while contracting at a high speed” (Baechle et al, 2008). Tests for muscular power are performed at maximal movement speeds in a very short amount of time. Therefore, when studying the biomechanics of a baseball or softball swing, it will be noticed that the most influential physiological factor is muscular power. For that reason, it is important to study which method to improve bat velocity actually produces the greatest improvement in muscular power while using the correct technique. Within this section I will discuss some of the research that illustrates the effects of both weighted bat training and trunk kinematics and the role they play on bat velocity.

Bat Training

A dry swing is defined as a batter swinging against no resistance. The correct chain of power transfer is completed starting with the feet, moving up the
legs and through the trunk, shoulders, arms, hands, and finally the bat. This drill is done without the use of a ball so that the participant can concentrate on proper swing mechanics. Sergo et al. (1993) examined the effects of various weighted bats on bat velocity with 24 collegiate baseball players. In his study one group swung a 62oz weighted bat, another group alternated between a 62oz weighted bat and a light bat, and the control group swung a bat of their choice (oz were not recorded). All groups completed 20 sets of five swings each with a rest interval of 20 seconds between sets, for three days a week for six weeks (Sergo et al. 1993). Bat velocity was measured by a light timing device, which was engineered by Lamar University. Sergo et al. (1993) concluded that there was a significant increase in bat velocity for all groups, however, there was no significant difference between groups. The increase in bat velocity could simply be due to the fact that all subjects were swinging a bat for a total of 300 times per week for six weeks (Sergo et al. 1993).

Other research suggests that a normally weighted bat can be as effective as a lighter bat in terms of increasing bat velocity. Montoya et al. (2009) examined the effects of a warm-up with different weighted bats on bat velocity on 19 recreationally active, male baseball players. Group 1 dry swung a light bat (9.6oz), Group 2 dry swung a normal bat (31.5oz), and Group 3 dry swung a heavy bat (55.2oz). All subjects completed five maximal swings with each of the three different weighted bats on three separate days, which were separated by 48 hours. Bat velocity was measured by a custom bat velocity device (Model E3Z; Omron Electronics, Schaumburg, IL). The researchers concluded that both
the warm-up with the light bat (9.6oz) and normal bat (31.5oz) produced a faster bat velocity than the warm-up with the heavy bat (55.2oz).

Reyes et al. (2009) examined the acute effects of various weighted bat warm-up protocols on bat velocity in 19 NCAA DIII collegiate baseball player from a team located in the Pacific Northwest. All subjects took part in nine separate testing sessions, which consisted of different protocols for each session. Each warm up consisted of six maximal-effort swings with each weighted bat (light- 794g, standard- 850g, heavy- 1,531g) for a total of 18 swings. A rest interval consisted of three to five seconds in-between each swing. Thirty seconds after each warm up session was completed subjects swung five times at a soft-toss pitch. Bat velocity was measured through a photocell control box, which was compared to pre warm up bat velocities. The average of five swings was recorded. Researchers of this study concluded that eight protocols increased bat velocity compared to the control group, however the order of standard, light, heavy bat sequence resulted in the greatest increase in bat velocity. It would appear that this sequence may be warranted to use in game situations.

With all of these findings in mind, it is still difficult to say which warm up protocol will elicit the most gains in bat velocity. No two studies suggest the exact same thing, though most suggest that warming up with a heavy bat will decrease bat velocity as compared to a light or normal bat warm-up.
Trunk Kinematics

The purpose of Stodden et al. (2008) study was to examine the maximum differential trunk rotation and maximum angular velocities of the pelvis and upper torso of athletes while they performed four trunk exercises that mimic to over arm throwing performance. The four trunk exercises included seated band rotations, cross-over’s, medicine ball throws, and twisters. The kinematics of these trunk exercises were compared with the trunk kinematics demonstrated while the athletes actually threw. The rectus abdominis, external oblique, internal oblique, and transverse abdominals are the main trunk musculature important in throwing mechanics. “The roles of this musculature in throwing are to promote dynamic stabilization, rotation, lateral bending, and flexion/extension of the trunk” (Stodden et al. 2008). To maximize the use of the trunk during throwing, throwers must be able to effectively use energy generated by the trunk musculature and transfer that energy through their system in the most efficient way possible. Not only will this energy transfer increase throwing velocity, but it also contributes to a decrease in the force demanded in the musculature associated with the shoulder and elbow joints. Furthermore, proper training of the trunk musculature should focus on increasing range of motion (ROM), strength, endurance, and velocity potential. Training for maximum differentiated trunk rotation and maximum angular pelvis and upper torso velocity will help to develop increased force through a greater ROM. This in turn will produce higher trunk velocities and more specifically, pitching velocities.
The seated band trunk rotations and lying cross-over crunches were included to demonstrate maximum ROM within the limitation of the specific exercise during the rotation of the torso and pelvis. The medicine ball throw was included to produce the greatest horizontal throw for distance. Finally, the twisters were included to have the subject rotate the trunk as quickly as possible while still emphasizing upper torso rotation. “Maximum upper torso velocities were calculated only for the twisters and the medicine ball throw because they were the only two exercises where velocity was critical for performing the exercise. Maximum pelvis velocities were examined only in the medicine ball throw because of the fact that the pelvis was primarily fixed to the ground in the twister exercise” (Stodden et al. 2008). All of the exercises were examined for maximum differentiated trunk rotation. This becomes important when trying to find a rotational exercise that mimics the movement you are trying to study.

The standing medicine ball throws require the participants to hold the medicine ball at chest level. “From this position, participants were instructed to rotate the body away from the directed line of the throw, producing a countermovement, then rotate in the opposite direction and throw the medicine ball for maximal horizontal distance” (Stodden et al. 2008). Participants were also instructed to keep elbows fully extended and shoulders flexed to mid-chest level. The weights of the medicine balls were between 3.7 and 4.5 kilograms. This exercise was performed five times in each direction.

During the twister exercise participants sat on the ground with their torso at 60 degrees to the floor and their feet approximately 10-15cm off the ground.
They were instructed to have their knees flexed to 90 degrees. “Participants held a 4.5kg plate on their chest with both hands. Participants were then told to rotate their upper body as far and as fast as possible from side to side for five complete rotations” (Stodden et al. 2008).

Data was taken as an average and split between dominant and non-dominant directions based on each participants throwing arm. The average maximum differentiated rotation of band rotations, cross-over’s, and twisters were also split between dominant and non-dominant directions. “Dominant rotation in the exercises for left-handed throwers was band trunk rotations to the right, cross-over to the right, and twisters to the right. Dominant rotation in the exercises for the right-handed throwers was band trunk rotations to the left, cross-over’s to the left, and twisters to the left” (Stodden et al. 2008). During the medicine ball throws, the preparatory movement for right-handed throwers was right rotation and throwing to the left. Oppositely, for the left-handed throwers the preparatory movement was left rotation and the throwing direction was right rotation.

During the twister exercise the goal was to obtain maximum upper torso velocity while the goal of the medicine ball throw was to produce maximum horizontal distance. Even though trunk rotation was not the goal for the twisters and medicine ball throws, they still produced greater trunk rotation than the cross over exercises. Therefore, the cross-over exercise was deemed to be the least effective in terms of velocity production. However, the cross-over’s could not be ruled out completely because they mimic the closest to trunk movement in
throwing. As a whole, all exercises in this study produced similar ROM during the actual throwing motion. Some skeptics may say that the medicine ball throw exercise was not a beneficial exercise to use because it does not closely mimic the throwing motion. However, it provides an estimate of the effects of adding mass to the distal aspects of the kinetic chain and increasing the distance from the axis of rotation to that distal end. The results of this study provide some convincing results as to what each exercise may provide in terms of having a training effect related to rotational and horizontal distance, which is paramount to proper kinematics. “Exercises that promote explosive trunk rotation, including torso twists with a partner (i.e., Russian twists) or explosive medicine ball throws, would seem to be the most appropriate exercises to specifically enhance trunk rotational velocities” (Stodden et al. 2008).

Explosive power generated from trunk rotation plays an important role in various movements associated with softball and baseball. Medicine balls are an appropriate implement for power training because there is no deceleration phase at the end of the concentric movement, similar to sports movements (Ikeda et al. 2009). During dynamic trunk rotation movements, such as the side medicine ball throw, a thrower can possibly stumble or lose balance due to the mass of the medicine ball at the distal aspect of their arm. This suggests that throwers need to stabilize the trunk musculature before their release point (Ikeda et al. 2009). Differences in performance may not only be due to a lack of strength within the trunk muscles, but can also be due to the lack of trunk muscle activation.
Yusuke Ikeda et al. (2009) examined electromyogram (EMG) activity of the trunk muscles during the fast side medicine-ball throw (FS-MBT) between two groups that displayed different throwing abilities; long throwers were those in the top five for throwing distance for the S-MBT and short throwers were those in the bottom five for throwing distance for the S-MBT. During the testing procedures on the first day subjects performed two S-MBT to the left while using a 4-kg medicine ball. The difference between S-MBT and FS-MBT is that S-MBT is to throw as far as possible, while FS-MBT is to throw as fast as possible emphasizing horizontal trunk rotation. Two trials of the S-MBT were separated by five minutes of recovery and the throw with the longest distance was recorded. The S-MBT was used to classify the subjects into long and short throwers.

During the testing procedures on the second day subjects performed the FS-MBT, which was separated by two days of rest. All subjects performed the FS-MBT to the left while using 2-, 4-, and 6-kg medicine balls. Subjects performed three successive trials with the same mass medicine ball and took approximately one minute of rest in-between. The same format was used for the other different weighted medicine balls. The throw with the highest velocity in the FS-MBT was recorded (Ikeda et al. 2009).

The researchers found that a person’s height or throwing release angle may have played a major factor on FS-MBT velocity within the highly trained athletes. The velocities between the 2-, 4-, and 6-kg medicine balls were significantly different between the long and short throwers. The decrease in
performance for the short throwers caused by the medicine ball mass in FS-MBT was slightly greater than that for the long throwers. It was also found from the EMG that activity of the external oblique was an important factor for FS-MBT, which is similar to that in sports performance.

Prepubescent Research

Many training programs are focused around strengthening the muscles associated with the shoulder since they are heavily involved in many movements involved in both baseball and softball. However, training programs should direct their focus to the entire kinetic chain including the torso and the full arm segment. Hitting is a full kinetic chain activity in which energy is transferred from the lower extremities, pelvis and torso, upper extremities, bat, and onto the ball when contact is made. The maximum amount of ballistic energy is applied to the ball when all of the body segments are in coordination with one another (Oliver et al. 2010). Results from the Oliver et al. (2010) study show that for prepubescent athletes a segmental progression must occur from proximal to distal body segments. The larger more proximal segments reach their peak angular velocities first, followed by the next distal segment, and eventually ending with the furthest distal segment (Oliver et al. 2010). According to Atwater (1979), “as each segment accelerated in turn, the succeeding segment first lagged behind, then acquired the speed of the segment moving it, and then accelerated to reach an even greater speed, while the proceeding segment decelerated.” Meaning that as the forearm slows the hand is increasing in velocity. Oliver demonstrates
the importance of training the entire kinetic chain because if one segment is left neglected then it can be detrimental to the whole kinetic chain performance. This can be seen within a softball swing because if one aspect of the swing is missing then optimal velocity and hitting performance cannot be reached.

There are many softball players of ranging ages around the country looking to improve their game offensively. Thus, it is important to research the effects of warm-up swings on bat velocity performance. The majority of the softball and baseball research has focused on dry swinging; therefore, this study will do the same, except using an additional training variable and working with a different population. This study will utilize dry swinging mainly focused on the on-deck circle warm up prior to the players “at bat”. Being able to generate an increase in bat velocity will potentially give the batter more time to determine whether they are going to swing at the pitch or not. If the hitter decides to swing, their bat velocity directly influences maximal force against the ball, thus generating a more powerful and farther hit ball. To the researchers knowledge there is no research involving both dry swinging training and medicine ball training within one study. In addition, there is no research that has used this type of protocol with prepubescent children. Therefore, the purpose of this study is to determine if an 8-week rotational medicine ball training protocol will increase bat velocity in a game like situation for prepubescent softball players. It is hypothesized that an 8-week rotational medicine ball training program will result in the greatest increase in bat velocity among prepubescent softball players.
CHAPTER III
METHODS

Participants

Twenty-seven female pre-pubescent softball players between the ages of 8-13 years old with at least 1-year softball experience were recruited to participate in this study. All participants were recruited from only recreational teams in the Northeast Ohio area. Recruitment procedures included contacting parents and female athletes the principle investigator has/had worked with and asked if they would like to volunteer to participate in the study. This study received approval by the Institutional Review Board from the Office of Research Services and Sponsored Programs at The University of Akron. In order to participate in this study participants and parents needed to sign both the child informed assent form and the adult informed consent form prior to the first day of testing. After these forms were signed, each participant’s age, height, and weight were recorded (Table 1).
Table 1

Descriptive Statistics

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yrs)</td>
<td>10.2</td>
<td>1.2</td>
</tr>
<tr>
<td>Height (in)</td>
<td>56.1</td>
<td>5.2</td>
</tr>
<tr>
<td>Weight (lbs)</td>
<td>82.8</td>
<td>25.3</td>
</tr>
</tbody>
</table>

Program Design

Participants arrived at the outside facility wearing athletic attire (shorts, t-shirt, and tennis shoes). Each participant participated in a familiarization trial where she learned how to warm up using a dry swing technique and how to hit pitches off the pitching machine. Participants were then randomly assigned to two groups: sports-specific medicine ball training (MB) (4lb or 6lb medicine ball) or control (Con). Before testing began, the participant’s dominant hitting stance and bat characteristics were recorded (Table 2 and Table 3). Pre- and Post-testing measures, separated by 8 weeks, were done for both groups.

Procedure

During the day of pre-testing, participants warmed up with 10 dry swings using the bat they normally use in competition. Immediately following their warm-up, participants then entered the batting cage to hit 10 pitches off the JUGS Super Softball Pitching Machine (JSSPM) with the same bat (Montoya, 2009, Reyes et al 2009, Sergo et al 1993). The velocities (mph) of all 10 swings were recorded. The speed of the pitches depended on the age of the participant.
Participants between the ages of 8-10 years hit a 40MPH pitch, while the 11-13 year old participants hit a 50 MPH pitch. Pitch speed was different between the participants because in a 10u fastpitch league pitchers normally throw a fastball between 38-42MPH and in the 12u league pitchers throw a fastball between 46-52MPH. All pitches thrown to participants were fastballs within the strike zone. Bat velocity of each of the ten swings was measured with each of the ten swings by a Swing Speed Radar Measurement Device (Sports Sensors, Inc.) (SSRMD) which was then averaged. During the ten swings, each participant was instructed to not look at their speeds on the SSRMD. Hits were recorded if they were successful or unsuccessful. Successful hits are classified as hits, usually line-drives, which would result in the player getting on base successfully without any error from the defense. An unsuccessful hit would be a pop-up or a slow grounder that could easily be handled by the defense, which would be recorded as an out. The principle investigator who has over 15- years playing experience and 10- years coaching experience supervised these decisions. All hits were recorded on each of the players’ data sheets.

Sports-Specific Medicine Ball Training Group

Within the 8 weeks the sports-specific training group completed a series of monitored medicine ball throws that were aimed at developing rotational velocity. The medicine ball throws include side medicine ball throw for distance, speed and accuracy, partner Russian twists, woodchoppers, and standing side band rotations. All exercises were done on both dominant and non dominant sides. Previous studies have shown these exercises to be most appropriate for
maintaining or developing muscular activation aimed to improve rotational velocity (Stodden et al. 2008; Ikeda et al, 2009). The 8-10 year old participants used a 4-kg medicine ball while the 11-13 year old participants used a 6-kg medicine ball. According to ACSM guidelines for children and adolescents, 8-15 repetitions of an exercise should be performed to the point of moderate fatigue with good mechanical form at least two days per week. The National Strength and Conditioning Association suggests the rest period between sets to be <30 seconds. After 8 weeks of training were completed, the post-testing began. The same protocol was used in post-testing as it was done in pre-testing.

During testing, the rotation of the participants progressed as follows: after one participant completed their 10 warm-up dry swings, they stepped into the cage and hit 10 pitches off the JSSPM. As that first participant begins to hit the 10 pitches from the JSSPM, the second participant then begin their 10 dry swings. This procedure was applied for all of the participants in both groups until testing was completed.
Table 2
Control Group Hitting Characteristics

<table>
<thead>
<tr>
<th>Subject #</th>
<th>Dominant Hand</th>
<th>Bat Name</th>
<th>Length (in)</th>
<th>Weight (oz)</th>
<th>Drop</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>R</td>
<td>Worth Storm</td>
<td>30</td>
<td>17</td>
<td>-13</td>
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<tr>
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<td>R</td>
<td>Worth Storm</td>
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<tr>
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<td>R</td>
<td>LS TPS Cypher</td>
<td>33</td>
<td>20</td>
<td>-13</td>
</tr>
<tr>
<td>4</td>
<td>R</td>
<td>Easton Cyclone</td>
<td>31</td>
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<td>-9</td>
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<td>30</td>
<td>20</td>
<td>-10</td>
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<tr>
<td>6</td>
<td>L</td>
<td>LS TPS Quest</td>
<td>30</td>
<td>18</td>
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<td>R</td>
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Table 3

Sport Specific Exercise Group Hitting Characteristics

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<tr>
<th>Subject #</th>
<th>Dominant Hand</th>
<th>Bat Name</th>
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<th>Weight(oz)</th>
<th>Drop</th>
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Instruments and Measurement Tools

In order to conduct this experiment, specific equipment was needed. Each participant used the bat she normally used in competition. Characteristics of all bats were recorded in Table 1.2. The Swing Speed Radar Measurement Device (Sports Sensors, Inc.) measured the bat velocity of each swing. Pitches were thrown by the JUGS Super Softball Pitching Machine 110v (speed is
regulated within the device). The balls pitched were JUGS Sting Free Yellow Dimpled Softballs. The medicine ball group used a 4lb or 6lb First Place Elite Medicine Ball and a 48” Low Powder Exercise Band (green- medium strength). The primary site for this study was an outdoor batting cage located in Northeast Ohio.
A 2 by 2 Repeated Measures ANOVA was used to compare the influence of a medicine ball training program on bat velocity performance. Statistical Package for the Social Sciences (SPSS) version 17.0 Windows program was used to evaluate the data collected. The mean, average, and standard deviation were assessed. When appropriate, a Post-hoc Bonferonni analysis was performed to determine where differences occurred. Statistical significance set a Prior at $P \leq 0.05$. The independent variables were the control group, which had no medicine ball training, and the medicine ball group, which completed an 8-week medicine ball training program. The dependent variable was the average bat velocity and average number of quality hits for all ten swings. The results of these tests will compare the average bat velocity and number of hits for each participant in each group.
CHAPTER V
RESULTS

During pre-testing, there was no significant differences observed between the control group (Con) and the medicine ball group (MB) in terms of mean bat velocity (Con= 36.07± 6.59mph, MB= 36.82± 5.40mph) and the average number of hits (Con= 5.14± 2.45, MB= 5.31± 2.63). After the 8-week training program was completed the post- test means showed no significant differences between the Con and MB groups in terms of bat velocity (Con= 38.22± 8.63mph, MB= 37.71± 4.42mph) and average number of hits (Con= 4.50± 1.83, MB= 4.92± 2.66).

Statistical analysis was performed using a Repeated Measures ANOVA, measuring differences within groups over time and between groups over time. In terms of bat velocity, the results revealed there was no significant difference from pre- to post-test over time ($p = 0.18$), ($F = 1.91$). It was also revealed that there was no significant difference between groups over time ($p= 0.54$), ($F= 0.33$). Results for the average number of hits revealed that over time there was no significant difference from pre- to post- test ($p = 0.35$), ($F = .91$). It was also revealed that there was no significant difference between groups from pre- to post- test ($p= 0.91$, $F= 0.06$).
Results from all tests revealed that both the Con and MB groups increased mean bat velocity from pre- to post- tests but not significantly (Con= 36.07± 6.59mph, 38.22± 8.63mph), (MB= 36.82± 5.40mph, 37.71± 4.42mph).
Figure 1. Pre- to Post- Testing Bat Velocity

Figure 2. Pre- To Post- Testing Number of Hits
Figure 3. Pre- to Post- Testing Bat Velocity for 8-10 Years Old

Figure 4. Pre- Post Testing Number of Hits for 8-10 Years Old
Figure 5. Pre- to Post- Testing Bat Velocity for 11-13 Year Olds

Figure 6. Pre- to Post Number of Hits for 11-13 Year Olds
CHAPTER VI
SUMMARY

One of the most important factors effecting bat performance in the game of softball is bat swing velocity (Smith et al, 2012). It has been reported that training programs composed of normal bat swings and other sport specific exercise modes, such as swinging differently weighted bats (DeRenne et al, 1995, Sergo et al, 1993), power resistance training (Schwendel et al, 1992), and rotational medicine ball training (Syzmanski et al, 2007) can increase baseline bat velocity. Therefore, the purpose of this study was to compare the acute affects of an 8-week medicine ball training program on bat velocity of prepubescent softball players. The results indicated that there was no significant difference in bat velocity between each group. Of the two groups that participated in this study, only the MB group participated in an 8- week training protocol. The protocol consisted of one set of five rotational exercises, each 8-15 repetitions on dominant and non-dominate sides, two times per week. Each of the exercises was designed to develop rotational velocity, which in turn would improve the athlete’s swing mechanics and bat velocity during competition. Many previous studies have researched the effects of weighted bat warm-up protocols on bat velocity and have found that pre-batting warm- up swings with a
weighted bat, despite a faster perceived bat swing by batters actually decreases bat velocity (Otsuji, 2002). Where as a faster bat velocities have occurred in competition following pre- batting warm- up swings with a bat each player normally uses in competition (DeRenne, 2009; Montoya, 2009; Sergo, 1993; Syzmanski, 2012). Therefore, this study encompassed a pre-batting warm- up with a bat normally used in competition and a sport specific training program designed to elicit strength gains in the rotational movement pattern of the swing with the purpose of improving the bat velocity of young softball players.

It is known that the majority of the strength gained by prepubescent athletes is based on movement pattern and neurological phenomenon. Previous research has looked at maximum voluntary isometric contraction conditioning (ISO) as a means to increase bat velocity in college baseball players. Higuchi et al. (2013) created an 8- week training program where the rate of increase is the post- ISO warm- up bat velocity of the experimental group was significantly greater then their control group. Within this study the ISO training was expected to elicit postactivation potentiation, meaning it has potential to improve explosive movements like that of swinging a bat. They discovered there could be limiting factors when utilizing postactivation potentiation mechanism for performance enhancement. For example, conditioning contraction with greater intensity and duration can suggest greater potentiation and fatigue concurrently (Higuchi et al. 2013). It also suggests that a longer recovery time promotes greater recovery and decreases the potentiation effect. Therefore, when creating a training program, especially for prepubescent athletes, work to rest ratio must be taken
into account to obtain optimal neurological and strength gains. As suggested by the National Strength and Conditioning Association, one to three sets of six to fifteen repetitions of single or multi-joint exercises on non-consecutive days is a safe and appropriate range for children participating in resistance training. In our study, all participants completed one set of ten to fifteen repetitions, with 1 minute of rest between sets, of each exercise two times per week. “Often the intensity and volume of training are too severe, and the recovery periods are inadequate for a child’s fitness level” (Baechle, 2008). Thus, program design, form, and technique were monitored at every training session to ensure the athletes’ safety.

It is a common misunderstanding that program design has to be different between women and men. “Since the physiological characteristics of muscle in the sexes are the same, there is no sensible reason why resistance training programs for women need to be different from those for men” (Baechle, 2008). The only true difference between the sexes when it comes to resistance training is the load used. The load for a female athlete should be decreased because female’s power output relative to total body weight is about 63% of males (Garhammer, 1991). In a recent study, Kumar et al (2001) reported that females produce only 65% of the torque produced by their male counterparts. However, few studies have measured the dynamic truck rotation using a medicine ball. They suggested that the majority of power output during a rotational medicine ball throw was contributed by contralateral pectoralis major in female athletes. The role of the pectoralis major in the softball swing is to adduct the arm and
internally rotate to provide the power of the swing (Pink, 1990). Thus, including a side- medicine ball throw for speed and accuracy was needed in this study in order to increase power output among these participants. It is important to note that while performing these throws, stabilization of the trunk is essential in terms of control when swinging the bat. Accordingly, when at batter is attempting to successfully hit a pitch thrown by the apposing pitcher, it is crucial to maintain in control of her swing in order to stay in the same plane of movement while making solid contact with the ball. Furthermore, after contact is made, the batter must be able to finish her swing while maintaining her position in the batters box and then running to first base in the most efficient way possible. If control is not maintained, the more likely it is that the hit will be unsuccessful. Which in turn results in an out and no contribution has been made in order to get a run on the board.

The improvement of softball performance through a sport- specific training program is the most adequate way to improve bat velocity. Newton et al. (1994) investigated the differences between upper- body ballistic movements and traditional upper- body resistance training exercise on average power, and peak explosive power. The results showed the ballistic movements draw optimal speed of movement and greatest concentric contraction force. Additionally, Szymanski et al. (2007) reported that a 12- week medicine ball training program that is specific to the rotational motion of baseball hitting could improve rotational strength of the trunk muscles and also increase bat velocity. For that reason, a training program that mimics the “swing” movement can be the most effective
means to improve bat velocity and hitting performance as long as the volume, load, progression, and safety of your athletes is the coaches' researchers priority.

Limitations of the current study include: the age and number of participants, no progression in the 8-week training program, possible overtraining effect, and the Swing Speed Radar Measurement Device. Because of the small population available only a small sample was taken. The mean age of the participants was 10.2 years, therefore if the age range of the participants was wider the results might have been different. Knowing that majority or strength gains are due to neurological adaptations, it may be more appropriate to use an older population to see gains in muscular power and bat velocity. Due to the lack of equipment, the participants only used one medicine ball weight (either 4lbs or 6 lbs) during the eight-week training program. Participants also completed the same number of sets (2) and repetitions (10) twice per week. The progression was not changed because only one researcher was responsible for 27 participants. At the prepubescent stage it is important as a strength and conditioning coach to understand the difference between chronological age and biological (training) age, thus appropriately assessing each of the 27 participants' ages and then creating an 8-week training program in a short amount of time was difficult. With that being said, it is possible that the participants adapted to the training stimulus and therefore needed a stronger training stimulus in order to gain significant improvements in bat velocity. On the other end of the training spectrum, it is also possible that the participants experienced an overtraining
Prior to participation in this study, it was deemed that none of the participants had experience with medicine ball training or any other resistance training of that nature, so it is possible that since the participants were doing the medicine ball workouts concurrently with their in-season games and practices, they experienced an overtraining effect. If possible, individualized programs would serve best in order to maximize bat velocity performance and to decrease the likelihood of overtraining. Finally, a Swing Speed Radar Measurement Device was the only device available for this study, which may not produce reliable results. There is no research available that deems this devise to be valid or reliable. Other studies (Reyes et al, 2009) have incorporated high technology photocell control box that have been found to yield reliable results in bat velocity. Future research should include proper progression in training programs for prepubescent athletes to achieve a proper training stimulus while also avoiding an overtraining effect, and to use high technology photocell devices if available. Traditionally, baseball players have used weighted implements to warm up in the on-deck circle in attempt to “loosen up” and to obtain greater bat velocity. Strength and conditioning coaches must become familiar with research on this topic and be prepared to educate players and hitting coaches on proper warm up protocols that increase bat swing velocity rather than decrease it.
REFERENCES


APPENDICES
Title: The Effects of a Medicine Ball Training Program on Bat Velocity of Prepubescent Softball Players

1. Our names are Mallory Kobak and Michael Rebold. We are both members of the Department of Sport Science and Wellness Education at The University of Akron.

2. I am asking you to take part in a research study because I am trying to learn more about what actions improve bat speed.

3. If you agree to be in this study you will be put into 1 of the 2 groups: control group or medicine ball group. The bats you will be assigned are a heavy bat, a light bat, and the bat you use regularly. On the first day you will learn how to warm up with your bat and how to hit pitches off the pitching machine. During the first day of testing you will warm up with 10 swings using your first assigned bat and after your warm up you will enter the batting cage to hit 10 pitches off the Pitching Machine with the bat you regularly use. On the second day of testing you will do the same exact thing except you will be using your second assigned bat. Finally, on the third day of testing you will once again do the same exact thing but you will use your third assigned bat.

   The speed of the pitches will depend on your age. If you are between the ages of 8-10 years you will be hitting a 40 MPH pitch. If you are between the ages of 11-13 year you will be hitting a 50 MPH pitch. All pitches from the pitching machine will be strikes.
If you are in the medicine ball group, for 8 weeks you will also complete monitored medicine ball exercises that are done to help improve your swing. If you are 8-10 years old you will be using a 4-kg medicine ball. If you are 11-13 years old you will be using a 6-kg medicine ball. You will be doing each medicine ball exercise 8-15 times, 2 times a week after your practice.

4. If you participate in this study you may feel tired or sore. To minimize this, Mallory and Michael (First- Aid and CPR Certified) will be monitoring and instructing you on the correct movements to minimize these risks.

5. Your participation may help us better understand which action will be most helpful to improve bat speed.

6. Please talk this over with your parents before you decide whether or not to participate. I will also ask your parents to give their permission for you to participate. But even if your parents say “yes” you can still say “no”.

7. If you don’t want to be in this study, you don’t have to. Remember, being in this study is up to you and no one will be upset if you don’t want to participate. If you change your mind later and want to stop, you can.

8. You can ask any questions that you have about the study. If you have a question later that you didn’t think of now, you can call me at 216-570-3118.

9. Signing your name at the bottom means that you agree to be in this study. You will be given a copy of this form to keep.

____________________________________  __________
Name of Subject      Age

____________________________________
Signature                   Date
APPENDIX B

ADULT INFORMED CONSENT FORM

Department of Sport Science and Wellness Education
College of Education
Akron, OH. 44325-5103
330-972-7738 Office
330-972-5293

The University of Akron
Institutional Review Board

Parental Consent for Children under 18

Title of Study: The Effects of a Medicine Ball Training Program on Bat Velocity of Prepubescent Softball Players

Introduction: Your child is invited to participate in a research project being conducted by Mallory Kobak, CSCS (student) and Michael Rebold, CSCS (faculty) in the Department of Sport Science and Wellness Education at The University of Akron.

Purpose: The purpose of this study is to determine if an 8-week rotational medicine ball training protocol will increase bat velocity in a game like situation in prepubescent softball players. It is hypothesized that an 8-week rotational medicine ball training program will result in the greatest increase in bat velocity among prepubescent softball players. The desired sample will consist of 30-40 female pre-pubescent softball players between the ages of 8-13 years old that will be recruited from only recreational teams within the Northeast Ohio area. It is required that these athletes have at least 1-year of experience playing fastpitch.

Procedures: Your child will arrive at the outside facility wearing athletic attire (shorts, t-shirt, and softball cleats). They will then go through a familiarization trial where they will learn how to warm up using a dry swing and how to hit pitches off the pitching machine. Participants will be randomly assigned to two groups: sports-specific medicine ball training (4-kg or 6-kg medicine ball) or control. Pre- and Post-testing measures, separated by 8 weeks, will be done for both groups.

During pretesting, the order of bats used for warm up will be randomly assigned for each participant. The bats are as follows: heavy bat (8-10 years- Bat 30in 18oz -12 or 11-13 years-33in 23oz -10), light bat (27in, 15.5oz -11.5), and the bat each use regularly in competition. During the first day of pre-testing your child will warm up with 10 dry swings using their first assigned bat. They will then enter the batting cage to hit 10 pitches off the Pitching Machine with
the bat they regularly use during competition. On the second day of pre-testing your child will warm up with 10 dry swings using their second assigned bat and then enter the batting cage to hit 10 pitches off the Pitching Machine using the bat they regularly use during competition. Finally, on the third day of pre-testing your child will warm up with 10 dry swings using their third assigned bat and then enter the batting cage to hit 10 pitches off the Pitching Machine using the bat they regularly use during competition. The speed of the pitches will depend on the age of your child. If your child is between the ages of 8-10 years they will be hitting a 40MPH pitch. If they are 11-13 years old they will be hitting a 50 MPH pitch. Their bat velocity will be recorded for each of their 10 swings using a bat velocity measurement device. Hits will also be recorded if they are successful or unsuccessful. Successful hits are classified as hits, usually line-drives, which would result in the player getting on base successfully without any error from the defense. An unsuccessful hit would be a pop-up or a slow grounder that could easily be handled by the defense to get that player out. Both of these measures will be recorded on each of the players' data sheets.

Pre- and Post-testing measures will be separated by 8 weeks. Within those 8 weeks the sports-specific training group (if your child is randomly assigned to that group) they will complete a series of monitored medicine ball throws that are aimed at developing rotational velocity. The medicine ball throws include side medicine ball throw for distance, side medicine ball throw for speed, partner Russian twists, woodchoppers and standing side band rotations. All exercises will be done on both dominant and non-dominant sides. If your child is 8-10 years old they will be using a 4-kg medicine ball. If your child is 11-13 years old they will be using a 6-kg medicine ball. According to The American College of Sports Medicine, the guidelines for children and adolescents are 8-15 repetitions of an exercise should be performed to the point of moderate fatigue with good mechanical form two days per week. The National Strength and Conditioning Association suggests the rest period between sets to be <30 seconds. Once the 8 weeks are completed post testing will begin. The same protocol will be used in post-testing as it was done in pre-testing for this group.

During both testing sessions the rotation of each child will go as follows: after one child completes their 10 dry swings they will then have two minutes of rest before they hit 10 pitches off the Pitching Machine. As that first child begins to hit the 10 pitches from the Pitching Machine, the next child will then begin their 10 dry swings. This procedure will be applied for all of children in both groups until testing is completed.

Exclusion: Participants recruited must be female softball players with at least 1 year of experience playing Fastpitch.

Risks and Discomforts: The risks associated with the study include include muscle soreness, shortness of breath, and the possibility of getting hit by a softball. To minimize risk investigaors are first aid, CPR, and AED certified. Investigators are also Certified Strength and Conditioning Specialists (CSCS), therefore, participants will be monitored and instructed on the correct techiques to minimize any associated risks.

Benefits: Your child may improve her bat velocity by her participation in this study.

Right to Refuse or Withdraw: Participants are volunteering under their and their parent's will, and can withdraw from the study at any time with no penalty. The child can refuse to participate even if the parent provides consent.

Anonymous and Confidential Data Collection: Any identifying information collected will be kept in a secure location and only the researchers will have access to the data. Participants will not be individually identified in any publication or presentation of the research results. Only aggregate data will be used. Your signed consent form and your child’s assent form will be kept separate from the data, and nobody will be able to link their responses to them.
Confidentiality of records: All participants will be assigned a number and all data will be stored in a binder that only Mallory Kobak CSCS, Michael Rebold CSCS, and Dr. Ronald Otterstetter have access to. All data will be kept until the maters thesis process is completed. Data will be then stored at InfoCision Stadium 307J for three years.

Who to contact with questions: If you have any questions about this study, you may call Mallory Kobak, CSCS at 216-570-3118 or Michael Rebold, CSCS at 440-227-1413 or Dr. Ronald Otterstetter at 330-972-7738. This project has been reviewed and approved by The University of Akron Institutional Review Board. If you have any questions about your rights as a research participant, you may call the IRB at (330) 972-7666.

Acceptance & signature: I have read the information provided above and all of my questions have been answered. I voluntarily agree to the participation of my child in this study. I will receive a copy of this consent form for my information.

__________________________________________  __________________________________________
Parent / Legal Guardian Signature                  Parent / Legal Guardian Signature

Name of Child ____________________________________
APPENDIX C
PRE- AND POST- TESTING RECORDING SHEET

Participant Name / Number
___________________ Group __________________
Age ____________ Height _____ Weight_____ Dominate ______
Bat Characteristics

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APPENDIX D

HUMAN SUBJECTS APPROVAL FORM

Office of Research Services and Sponsored Programs

May 29, 2012

Mallory Kobak
6983 North Renwood Road
Independence, Ohio 44133

From: Sharon McWhorter, IRB Administrator

Re: IRB Number 2012-0507 “The Effects of a Medicine Ball Training Program on Bat Velocity of Prepubescent Softball Players”

Thank you for submitting an IRB Application for Review of Research Involving Human Subjects for the referenced project. Your protocol represents minimal risk to subjects and has been approved under Expedited Category #4.

Approval Date: May 29, 2012
Expiration Date: May 29, 2013
Continuation Application Due: May 15, 2013

In addition, the following is/are approved:

☐ Waiver of documentation of consent
☐ Waiver or alteration of consent
☐ Research involving children
☐ Research involving prisoners

Please adhere to the following IRB policies:

- IRB approval is given for not more than 12 months. If your project will be active for longer than one year, it is your responsibility to submit a continuation application prior to the expiration date. We request submission two weeks prior to expiration to insure sufficient time for review.
- A copy of the approved consent form must be submitted with any continuation application.
- If you plan to make any changes to the approved protocol you must submit a continuation application for change and it must be approved by the IRB before being implemented.
- Any adverse reactions/incidents must be reported immediately to the IRB.
- If this research is being conducted for a master's thesis or doctoral dissertation, you must file a copy of this letter with the thesis or dissertation.
- When your project terminates you must submit a Final Report Form in order to close your IRB file.

Additional information and all IRB forms can be accessed on the IRB web site at:
http://www.uakron.edu/research/onsps/compliance/IRBHome.php

Cc: Ronald Otterstetter - Advisor
Cc: Michael Rebold - Co Pi
Cc: Stephanie Woods – IRB Chair

☑ Approved consent form/s enclosed