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Effects of Various Training Techniques on Bat Velocity of High School Baseball Players

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Abstract

Faster bat speed allows a baseball or softball player more time to decide how to hit the ball and provides more transfer of momentum to the ball (Nathan, 2003; Syzmanski, DeRenne, Spaniol, 2009). ***Purpose:*** *This paper examines the effectiveness of three training strategies for improving bat speed among high school baseball players.* ***Methods:*** *Nine high school students were recruited and separated into 3 groups using different training implements. A standard bat (29 oz.), a weighted bat (45 oz.), and Therabands attached to a standard bat were used over a 3-week training program. Data were analyzed using a Kruskal-Wallis ANOVA.* ***Results:*** *The standard bat group experienced no change in bat speed (± 0.89), while the weighted bat group increased by 1.9 ± 0.46 mph and the Theraband group improved by 3.1 ± 0.38 mph. The only significant difference was in the change in bat speed between the Theraband group and the standard bat group ($p = .022$). All other data were non-significant.* ***Conclusions:*** *Attaching Therabands to a standard bat may be an effective training tool to improve bat speed.*

Keywords: bat speed, standard bat, theraband, weighted bat, training implements

1. Introduction

Bat swing velocity is one of the most important components of a baseball or softball swing. A high swing velocity is vital for hitting success because it allows the hitter to decrease their total swing time, increase their decision-making time, and increase ball exit velocity (Nathan, 2003; Szymanski, DeRenne, & Spaniol, 2009). All of these factors can improve a baseball or softball players' offensive game performance.

Many studies have tried to identify both short-term and long-term training tools to improve bat velocity (DeRenne & Szymanski, 2009; Higuchi, Nagami, Mizuguchi, and Anderson, 2013; Kim, 2013; Kobak, Rebold, Buser, Kappler, & Otterstetter, 2018) Liu, Kiu, Kao, and Shiang, 2011; Montoya, Brown, Coburn, & Zinder, 2009; Pillmeier, Litzenberger, & Sabo, 2012; Szymanski et al., 2009; Szymanski et al., 2011; Szymanski et al., 2012; Wilson et al., 2012). The studies included in this literature review looked at various warm-up implements for athletes to use in the on-deck circle as well as training implements that were used for multiple weeks to increase bat swing velocity.

1.1 On-Deck / Short-Term Strategies

DeRenne and Szymanski (2009) conducted a general review of weighted baseball implement training which described general guidelines for utilizing weighted bat implements for baseball. This review reported that on-deck, warm-up implements weighing ± 12% of the standard bat weight (30 ± 3.6 oz) showed an increase in bat velocity for high school, college, and ex-college baseball players. Studies using implements that were over or under this 12% limit showed either no significant improvement or a reduction in bat velocity (DeRenne & Szymanski, 2009).

This information was intriguing because warming up with a heavier bat or weighted implement has been a common on-deck routine for baseball and softball players for many years. It was originally thought that swinging a heavier bat would make the standard bat seem lighter and, therefore, allow the athlete to swing their bat faster (Southard & Groomer, 2003). In order to test this theory, multiple studies have tested the effect of warm-up devices on bat velocity. Surprisingly, the majority of the studies showed that there was no difference in bat velocity or that warming up with heavier weighted implements (>12% standard bat weight) showed a reduction of bat velocity (Kim, 2013; Szymanski et al., 2011; Szymanski et al., 2012; Wilson et al., 2012). In spite of no beneficial change in bat speed, coaches and athletes may gravitate toward heavier implements because of the sensation of greater "normal" bat speed, identified as "kinesthetic aftereffect" (Southard & Groomer, 2003).

Additionally, some studies have identified that swinging lightweight implements as a warm-up device showed an increase in bat velocity (Montoya et al., 2009; Pillmeier et al., 2012). Montoya, Brown, Coburn, and Zinder (2009) performed a study on 19 male recreational baseball players that compared the effect of three warm-up weights; light (9.6 oz), normal (31.5 oz), and heavy (55.2 oz). This study showed a significant improvement of bat velocity with the group that was assigned the light bat warm-up implement (Montoya et al., 2009).

Similar findings were found by Pillmeier, Litzenberger, and Sabo (2012) when they analyzed four male amateur baseball players. This study also compared the effect of light (.68 kg), normal (.88 kg), and heavy (1.73 kg) weighted bats on bat velocity. Again, the highest bat velocity that was found in this study belonged to the participants that swung the lighter bat. These findings suggest that, in terms of on-deck warm-up, light weight swinging implements can be an effective tool for increasing bat velocity (Pillmeier et al., 2012).

1.2 Training / Long-Term Strategies

Other popular means of increasing bat velocity include weighted training implements and/or sport-specific training programs. Most studies so far have analyzed the effect of swinging a weighted implement over a long period of time (> 8 weeks) or performing a workout program consisting of sport-specific movements for improving rotational velocity (Higuchi et al., 2013; Kobak et al., 2018; Liu et al., 2011; Szymanski et al., 2009).

In order to swing a heavy bat, an athlete may rely on poor mechanics to execute the movement because the bat is longer and heavier than normal (Liu et al., 2011). A study performed by Liu et al. (2011) showed improved bat velocity with a weighted device. This study was unique in that it analyzed a training tool that is relatively new to baseball and softball. The dynamic moment of inertia bat was designed to have the weight start near the handle of the bat and slide down as the hitter progresses through their swing. This device allows the athlete to use a weighted bat while reducing the chance of compromising their swing mechanics. Liu et al. (2011) found that bat velocity, hitting distance, and muscle power of each arm was increased after 8 weeks of training with the dynamic moment of inertia bat.

Bat velocity also increased with a periodized, sport-specific training program. Higuchi, Nagami, Mizuguchi, and Anderson (2013) studied the long-term effects of isometric contraction conditioning on bat velocity in 24 collegiate baseball players. The study required the participants to perform an isometric contraction at the point of ball contact 3 days per week for a total of 8 weeks. The results showed a significant increase in bat velocity after the 8-week training protocol (Higuchi et al., 2013).

Kobak, Rebold, Buser, Kappler, & Otterstetter (2018) analyzed the effect of medicine ball training on bat velocity in 27 prepubescent softball players. The participants performed 8 weeks of medicine ball exercises aimed at improving rotational velocity (Kobak et al., 2018). No significant differences in bat velocity were discovered; however, it should be noted that the authors did not periodize the training program. The participants used the same weight and training volume throughout the entire study, meaning that there was little opportunity for continued adaptation to the training (Kobak et al., 2018). These findings are contradictory to those by Szymanski et al. (2009), who found improvements in bat velocity with a training program that incorporated rotational medicine ball exercises. In light of the adaptations found by Liu et al. (2011) and Higuchi et al. (2013), the findings from Kobak et al. (2018) reveal the importance of periodization for generating meaningful adaptation to training.

Szymanski et al. (2009) performed 3 different 12-week studies on high school baseball players utilizing a combination of resistance training and supplemental swing exercises. All 3 studies used the same full body resistance training protocol (7 exercises, stepwise model, 65-85% 1RM) while the supplemental swing exercises varied for each study. These supplemental exercises consisted of dry swings with a game bat in the first study, dry swings and 4 rotational medicine ball exercises in the second study, and handgrip and forearm exercises in the third (Szymanski et al., 2009).

The results of these 3 studies showed an increase in bat velocity regardless of the supplemental exercise that was used. This indicates that a general resistance training program with supplemental exercises that are specific to baseball can improve bat velocity (Szymanski et al., 2009). Furthermore, these results suggest that specificity of exercise may be another vital key to long-term bat velocity training.

1.3 Conclusion

In conclusion, research has shown multiple techniques to increase bat velocity using both short-term implements and long-term training programs. When using on-deck or warm-up implements for increasing bat velocity, coaches should encourage players to utilize implements that are within ± 12% of the standard bat weight. Warm-up implements that were over or under the suggested 12% weight significantly reduced or failed to improve of bat velocity.

Increasing bat velocity through a training program seems to follow the general guidelines for creating a strength and conditioning program. The studies that showed an improvement of bat velocity included sport-specific movements with a periodized training program. The only program that did not show an improvement in bat velocity included sport-specific movements but no periodization throughout the 8-week program. This may suggest that there is a heavier reliance on the increase in training volume compared to exercise selection; however, more research is warranted before this assumption can be clarified.

The purpose of the current study is to evaluate the impact of a short duration (3 week) training program using a weighted implement or bands on bat velocity among high school baseball players.

Method

The Institutional Review Board at the lead investigator's institution approved this study.

2.1 Participants

The participants consisted of 9 high school baseball players who volunteered for this study (ages= 16-18 years old, height = 71.3 ± 4 inches, weight= 177.2 ± 53 lbs). All of the participants in this study had previous baseball experiences at the high school or the statewide youth baseball program (ages 15-19) level. Prior to participating in this study, parental consent was obtained along with a health history questionnaire, Physical Activity Readiness Questionnaire (PAR-Q), and informed consent. In August prior to the study, all volunteers were required to pass an athletic physical to be eligible to participate in any sport affiliated with a public high school. Based on the physical exam and questionnaires, all participants were deemed healthy enough to take part in the study.

2.2 Design

This study was a randomized, control study. The participants were randomly assigned to the three groups: a standard bat group, a weighted bat group, and a Theraband group. The standard bat group served as the control group.

2.3 Instrumentation

JUGS Professional Sports radar gun, which recorded speeds in miles per hour (MPH), was used to measure bat velocity. This radar gun measures speeds that range from 5-140 MPH with an accuracy of ± 0.5 MPH (The JUGS Gun™, 2018). The radar gun was calibrated with a tuning fork prior to each testing session to clarify that it was reading the correct MPH (JUGS Sports™, 2011). The radar gun was positioned approximately 10 feet in front of the batter to measure the bat velocity of each swing. The official high school baseball, Wilson A1010, was utilized throughout the study. All participants used a 2016 Rawlings 5150 BBCOR baseball bat that measured 32 inches long and weighed 29 ounces. The baseballs were placed on a Champro Rubber Batting Tee so that height could be adjusted to align with the participant's iliac crest, which simulated a pitch that was thrown to the middle of the strike zone.

For the training sessions, there were 2 tools used for this study: a 16-ounce Easton bat weight and a variety of Theraband Latex Exercise Tubing. The 16-ounce bat weight was added to the standard bat creating a total bat weight of 45 ounces. This was the "weighted bat" used for the duration of the study. The second training tool used comprised of an assortment of Theraband Latex Exercise Tubing to add resistance during the swing. Each participant chose their own Theraband by using the color that provided a moderate amount of resistance during their swing.

2.3 Procedures

2.3.1 Pre-test

All participants took a pre-test to measure their bat velocity prior to the training sessions. Participants completed a generalized dynamic warm up and practice swings off of the tee before the testing initiated. During the pre-test, participants were instructed to conduct 3 game-like swings with the standard bat while generating as much bat velocity as they could. The tee was adjusted so that the baseball was even with the top of the iliac crest. As stated earlier, this position was selected because it replicated a ball that was thrown to the middle of the strike zone.

Once the tee height was properly adjusted, the participant was told to swing whenever they were ready. Bat velocity was measured using the JUGS Professional Sport Radar Gun, which was placed behind a screen positioned directly in front of the baseball in line with the pitcher's mound. This radar gun position was selected because, according to the owner's manual, this provided the most accurate reading. The participant completed three swings; the average velocity of the 3 swings was used as the participant's pre-test bat velocity.

2.3.2 Training sessions.

After the pre-testing was completed, participants were randomly assigned to one of three groups: a standard bat group, a weighted bat group, and a Theraband group. Participants met 5 days per week for 3 weeks for a total of 15 sessions. During these training sessions, participants were given their specified training tool to increase bat velocity. The standard bat group used the predesignated standard, non-weighted, bat. The weighted bat group added the 16-ounce bat weight to the standard bat, making it weigh a total of 45 ounces. The final group used various Therabands to create a moderate amount of resistance throughout the swing. This was not predetermined like the standard bat or weighted bat, which made it more individualized for each participant.

The participants in the Theraband group determined which colored band to use after they completed the warm up. Participants were instructed to choose the band that provided a moderate resistance from the beginning of their swing to their contact point. Because the bands created more resistance as the swing was further executed, the participants were able to reach contact, but were not able to complete the follow through portion of their swing. The Therabands were connected to a pole that was directly behind the hitter. The bands were connected to the bat 2 inches above the grip of the bat. This positioning allowed the participants to maintain as much of a normal swing as possible.

Prior to each training session, the participants were led through a generalized dynamic warm-up routine that consisted of upper and lower body stretches. The participants then warmed up their swings by hitting baseballs off of a tee at their own pace. After the participants were ready, they separated into their designated training groups and began the training protocol.

All groups had the same training protocol. Each participant was instructed to take 25 game like swings, with each swing being on a cue. A 30-second rest period began after each swing was completed to ensure the participant received adequate rest. After completion of 15 training sessions, a post-test was conducted.

2.3.3 Post-test

The post-test was conducted in the same manner as the pre-test. The average velocity of the 3 swings was used as the post-test bat velocity.

2.4 Statistical Analysis

All statistical analyses were completed using IBM SPSS Statistics 23. A Chi Square test was run to ensure there were no significant differences among the pre-test groups. After this was determined, a Kruskal-Wallis ANOVA was conducted to determine differences between pre- and post-test bat velocities within groups. Significance was set at an α of ≤ 0.05.

Results

The results showed minimal change in bat velocities between groups. Table 1 shows the average bat speeds at pre-test and post-test for all groups. All groups were similar at baseline based on the Chi Square analysis of the pre-test bat velocities. The Kruskal-Wallis ANOVA revealed no significant differences in the post-test scores among the three groups ($p > .05$). However, when the difference between pre- and post-test velocities was accounted for, the model recommended rejecting the null hypothesis ($p = 0.027$). The only significant difference was found to be between the Theraband and the standard bat group ($p = .022$) when evaluating the change in bat speed.

	Pre-test (mph)	**Post-test (mph)**	**Change (mph)**
Weighted Bat (n = 3)	71.0 ± 4.7	72.9 ± 4.9	1.9 ± 0.5
Theraband (n = 3)	73.9 ± 11.7	77.0 ± 11.5	3.1 ± 0.4*
Standard Bat (n = 3)	73.9 ± 4.5	73.9 ± 5.4	0.0 ± 0.9

*Statistically significant ($p < 0.05$).

Table 1 Average Bat Speed Velocity for Each Group, Mean ± SD

The results of the study showed minimal significant differences, but it should be noted that there were some positive improvements seen in the averages of the weighted bat group as well. The average bat velocity for the weighted bat group before the training program was 71.0 ± 4.7 mph and the average bat velocity post training improved to 72.9 ± 4.9 mph. This shows that there were improvements seen with the weighted bat technique, but not at a statistically significant level. On the other hand, the change in bat speed for the Theraband group was statistically significant.

Discussion

Having optimal bat velocity during game-like swings is important to be a successful hitter in baseball. Individuals who have a faster bat velocity will have a longer time to track the ball, decide if it is a ball or a strike, and then begin the swing (Syzmanski, DeRenne, Spaniol, 2009). Additionally, a faster bat swing leads to an increased ball exit velocity (Nathan, 2003). The purpose of this study was to examine which training technique (standard bat group, weighted bat group, and Theraband group) improved the bat velocity of high school baseball players the most. The findings of this study showed that resistance bands had the greatest impact on bat velocity.

Although there were no statistically significant differences found in the weighted bat group, the average speed did improve by 1.9 mph. The lack of significance may be attributable to the fact that the total weight chosen for the weighted bat group was outside of the ± 12% standard (DeRenne & Szymanski, 2009). This may be because the weight chosen for this study was simply too heavy for high school players even though there was a trend toward faster bat speed.

The lack of improvements may have been due to the failure to periodize either with the bat weight or with an increase of overall number swings each week. A study conducted by Higuchi et al. (2013) showed that a periodized, sport-specific training program showed an improvement in bat swing velocity over an 8-week period. The current training program used a set number of swings in every session, which may have contributed to the lack of significant findings.

This may also help explain why the Theraband group was more successful at improving bat velocity. Not only was the Theraband group within the ± 12% range, but the resistance was also able to be increased according to the participant throughout the duration of the study. At the beginning of each session, participants were asked to select a resistance band that provided a moderate amount of resistance. As the participants progressed through the training program, the Theraband resistance increased as well. This may have provided the participant with a mild amount of periodization throughout the program, which is the most likely explanation for the Theraband group producing a significant improvement in bat velocity.

Practical Applications

Coaches who are hoping to improve the bat speed of their high school athletes may find that bands are the best choice. If coaches have longer than 3 weeks to train their athletes for these improvements, they may find that a heavy weighted bat is also beneficial. There was an improvement in bat speed among the weighted bat group, which allows this recommendation. However, other research shows that a lighter bat and a periodized training plan would be more likely to have a positive impact on bat speed (DeRenne & Szymanski, 2009; Higuchi et al., 2013; Kobak et al., 2013).

Future research needs to focus on techniques to improve bat velocity that are within ±12% of an individual's game bat weight and follow a periodized format. Specifically, research should examine how much periodization is needed to see improvements when it comes to baseball or softball swing progressions. There are currently no guidelines in place for a periodized swing program both with and without training implements.

Conclusions

In conclusion, research has shown multiple techniques may be used to increase bat velocity using both on-deck/short-term and training/long-term strategies. When using on-deck warm-up implements for increasing bat velocity, sport coaches as well as strength and conditioning coaches should encourage players to utilize implements that are within ± 12% of the standard bat weight, according to previous research (Kim, 2013; Szymanski et al., 2011; Szymanski et al., 2012; Wilson et al., 2012). Training, or long-term, strategies should emphasize similar weights to the on-deck strategies and rely heavily on periodization to increase the likelihood of success.

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