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Effects of Weighted Bat Implement Training on Bat Swing Velocity

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Reference Data
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ABSTRACT

The purpose of this study was to determine the effects of weighted bat training on bat swing velocity. Sixty male university baseball players volunteered to participate and were randomly assigned to one of three equal-sized training groups: batting practice (BP), dry swing (DS), and control. The BP hit live pitched baseballs with alternated overweighted, underweighted, and standard 30-oz bats for 12 weeks. The DS dry-swung with alternated overweighted, underweighted, and standard bats. The control group dry-swung with a standard bat during the 12 weeks. All three groups showed significant increases in bat swing velocity during the study ($p < 0.05$). Furthermore, the differences between pre- and posttest scores (delta scores) were significant between BP and control, between DS and control, and between BP and DS ($p < 0.05$). It is suggested that training with variable weighted implements will significantly increase bat swing velocity, and that the use of loads specific to the target activity but with sufficient variation about the standard load will induce further training adaptations.

Key Words: baseball, specificity, exercise

Introduction

Bat velocity is a major mechanical characteristic of a good hitter (2). Increased bat swing velocities prior to bat-ball impact will result in increased batted-ball velocities and therefore are an important consideration in developing baseball training programs (1). Researchers have indicated that bat swing velocity can be increased by resistance training. DeRenne and Okasaki (4) showed that bat swing velocity could be increased by using a commercial Power Swing (air resistance device) or a special heavy weighted bat (963.9 g or 34 oz). Sergo and Boatwright (8) reported that swinging a bat of any weight would significantly improve bat velocity. However, Gilligan (6) concluded that weight training per se did not improve bat swing velocity but that the combination of weight training and swinging a heavy bat did improve velocity.

Training protocols using light and heavy implements have reportedly increased bat swing velocity (8). However, we are not aware of any study investigating the effect of an alternating bat weighted training program combining standard, light, and heavy bats (± 85.1–113.4 g). Therefore the purpose of this study was to determine the effects of variable weighted bat training on bat swing velocity.

Methods

Subjects

Sixty Div. I-A collegiate varsity-level baseball players volunteered for this study. Their biometric profile and years of varsity level participation are listed in Table 1. The subjects were given a detailed explanation of the training and testing procedures to be used, and each completed a health-fitness questionnaire and signed an informed consent document.

The subjects were randomly assigned to one of three groups, 20 in each. The batting practice (BP) and dry swing (DS) groups used underweighted bats ranging from 766 to 822 g (27–29 oz) and overweighted bats ranging from 879 to 964 g (31–34 oz). The control group used the standard bat weighing 851 g (30 oz). All three groups trained 4 days a week for 12 weeks. The control group was instructed to dry-swing (swinging a bat using proper mechanics without attempting to hit a thrown baseball) 150 times a day (15 sets of 10 swings with no more than a 30-sec rest between sets). This protocol reflects a normal batting practice training session in collegiate baseball practice. The DS group was also instructed to dry-swing 150 times a day. The BP group was instructed to hit live pitched baseballs 150 times a day.

The BP and DS groups alternated heavy, then light, then standard weighted bats (10 swings per bat per set, for 5 sets, with no more than a 15-sec rest between each bat and no more than a 30-sec rest between sets) for a total of 150 swings. The weight of the bats for BP and DS went up and down by 1 oz every 3 wks. During the training schedule, shown in Table 2, training swings for all three groups were monitored and corrections were made to reinforce traits identified

Table 1
Mean Biometric Data for All Groups

Group	Age (yrs) *M*	Age (yrs) *SD*	Height (cm) *M*	Height (cm) *SD*	Weight (kg) *M*	Weight (kg) *SD*	Varsity exper. (yrs) *M*	Varsity exper. (yrs) *SD*
1 (*n* = 20)	19.6	0.3	179.7	4.3	76.7	5.6	1.4	0.6
2 (*n* = 20)	19.4	0.3	179.1	5.1	77.8	5.6	1.2	0.7
3 (*n* = 20)	19.3	0.2	178.3	5.3	76.9	6.8	1.1	0.6
Tot. = 60	19.5	0.3	178.9	4.9	77.1	5.9	1.2	0.6

Table 2
Training Schedule, Lesson Plan Structure, and Bat Weights

Weeks	Total swings	Sequence of swings	Weight of bats (oz)
Batting Practice group			
1–3	150	50/50/50 (H/L/S)	31, 29, 30
4–6	150	50/50/50 (H/L/S)	32, 28, 30
7–9	150	50/50/50 (H/L/S)	33, 27, 30
10–12	150	50/50/50 (H/L/S)	34, 27, 30
Dry Swing group			
1–3	150	50/50/50 (H/L/S)	31, 29, 30
4–6	150	50/50/50 (H/L/S)	32, 28, 30
7–9	150	50/50/50 (H/L/S)	33, 27, 30
10–12	150	50/50/50 (H/L/S)	34, 27, 30
Control			
1–3	150	50/50/50 (S/S/S)	30
4–6	150	50/50/50 (S/S/S)	30
7–9	150	50/50/50 (S/S/S)	30
10–12	150	50/50/50 (S/S/S)	30

Note. 4 sessions in each week.
S = standard 30-oz bat, H = heavy bat, L = light bat.

by Breen (2) and Race (7). All baseball bats were weighed and checked for denting effects twice a week, and any bat found defective was replaced. At the end of the 12-week period subjects were retested with the same materials and testing procedures as for the initial test.

Instrumentation and Testing Procedures

Based on previous research on the effects of various weighted warm-up implements on bat swing velocity (3), a bat weight range of 766 to 964 g (27 to 34 oz) was selected for this study. The research had found that weighted bats in this range significantly increased bat swing velocity after warm-up ($p < 0.05$). Therefore we chose to use the same weighted range in this training study: 4 overweighted bats at 964 g (34 oz), 936 g (33 oz), 907 g (32 oz), and 879 g (31 oz); 1 standard weight bat (851 g, or 30 oz); and 3 underweighted bats at 822 g (29 oz), 794 g (28 oz), and 766 g (27 oz). The underweighted and overweighted precision handcrafted aluminum bats we used were constructed to specification and had identical lengths and shapes.

Subjects were pre- and posttested for bat swing velocity by being positioned in their normal batting stance, as previously reported (3). The instrument used to measure bat velocity was a photosensing computerized timer (3, 8, 10). The photosensing computer was designed and constructed for this study; its mechanism consisted of two photo-detector sensors spaced 10.16 cm apart with two light beams striking the sensors on a vertical axis.

The computer's reliability was determined by the repeatability of the timing device. At 24.6 $m \cdot s^{-1}$, the average tested bat velocity, the time was measured with a repeatability of 3.5 microseconds, which, for a measured period of 4.1 milliseconds, represents a variation of 0.1%. Therefore the measurement of time and thus bat velocity was determined to be sufficiently accurate (3). The average velocity of 10 trials was used to represent batting velocity for each subject.

Statistical Analysis

Prior to the 12 weeks of training, a one-way ANOVA was conducted on pretest bat velocities among the three groups to rule out any differences. Following the training, *t* tests were conducted between pre- and posttest scores for each group. In order to detect the specific treatment effect on bat swing velocity, a one-way ANOVA was done on the differences between pre- and posttest scores (delta scores) for all three groups. Significant differences between groups were determined through a Scheffé post hoc *F* test. The alpha level for all statistical tests was set at $p < 0.05$.

Results

It was determined from the pretreatment ANOVA that there were no differences ($p = 0.26$) among groups for bat swing velocity. Pretreatment mean (±*SD*) bat swing velocities for the BP, DS, and control groups were 34.6 (2.1), 35.8 (3.4), and 35.9 (2.8) $m \cdot sec^{-1}$, respectively. Posttreatment mean (±*SD*) bat swing velocities for the BP, DS, and control groups were 38.0 (2.3), 37.8 (2.9), and 36.4 (2.6) $m \cdot sec^{-1}$, respectively.

The findings of the pre/posttreatment *t* test (paired two-tail) within groups indicated that all three groups had significant increases in bat swing velocity ($p < 0.05$). The BP group increased 10% ($p = 0.0001$), the DS group 6% ($p = 0.0001$), and the control group 1% ($p = 0.03$) in pre/post bat swing velocity. Furthermore, significant differences, $F(2,57) = 30.16$, $p = 0.0001$, in the changes in bat swing velocity, pre- to posttraining, were also observed between the experimental groups. The Scheffé post hoc *F* testing revealed significant velocity improvements for the BP and DS groups as compared to the control group. Additionally, the BP group showed significantly more improvement than the DS group ($p < 0.001$) (Figure 1).

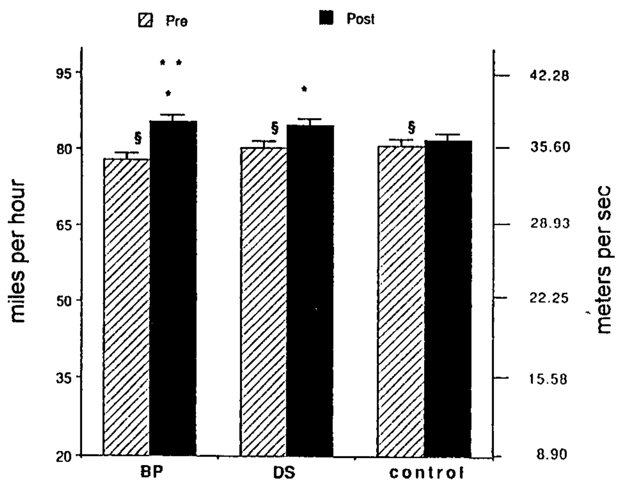

Figure 1. Mean (±*SE*) bat swing velocity for collegiate varsity baseball players. Signif. diff.: § within groups (all groups); *between groups (BP vs. control, DS vs. control); **between groups (BP vs. DS). Alpha level $p < 0.05$; Model II estimate of between-component variance = 2.08.

Discussion

Our findings suggest that either the BP or DS training protocol can significantly increase bat swing velocity in collegiate baseball players ($p < 0.05$). Since no additional weight training or batting practice was allowed during the 12-week treatment period, the velocity improvements can be attributed to the swinging and hitting with variable weighted bats. This would suggest that the use of a combination of weighted bats can serve as an adjunct training method to significantly increase bat swing velocity in college age baseball players.

The results are in contrast to those of Sergo and Boatwright (8), who also worked with college players and reported significant bat velocity increases for each group but no significant differences between groups using weighted bats. In their study the control subjects used a legal bat of their own choice (822, 851, 879 g), the first experimental group used an overweighted bat of 1,758 g (62 oz), and the second experimental group alternated a heavy (1,758 g) bat and a light fungo bat. Each group produced a significant increase in bat velocity (8 to 8.8%) over the training period. Sergo and Boatwright (8) concluded that swinging any weighted bat 100 times a day 3 days a week significantly increases bat velocity. But they were not certain that using a heavier bat or interchanging a fungo bat with a heavy bat develops greater bat speed than using a regulation bat.

The fact that the overweighted bat in the Sergo and Boatwright (8) study was 907 g greater than standard (851 g), and that the overweighted bat in the present study was only 57 g heavier than standard, may account for the differences in findings of these two studies. Additionally, Sergo and Boatwright's control subjects had a choice of training bats and may actually have trained with underweighted bats. Furthermore, the 879-g (31-oz) testing bat used in Sergo and Boatwright's study was 28 to 57 g heavier than the two most popular bats (822 and 851 g) used at the university level. If most of the subjects use a standard bat of 822 to 851 g (29 to 30 oz) in games, then the 879-g testing bat used in Sergo and Boatwright's study was an overweighted implement.

Based on the present study, it appears that there is a possible transfer training effect when the elements of the supplementary and overloading exercises (e.g., weight training) are similar to those of the primary activity (baseball skills). Weighted implement training consists of exercising with modified standard competitive implements while duplicating the accelerative nature and full range of motion of the specific hitting pattern. According to our results, if the implements are no more than 12% heavier or lighter and have the correct heavy/light/standard resistance load ratios, bat velocities will increase significantly ($p < 0.05$).

Baseball hitting is a high-velocity ballistic movement in which velocity is directly related to optimal performance. Although the neurophysiological mechanism for increasing movement velocity is not fully understood at this time, some researchers indicate that the peak power output of fast-contracting muscle fibers can be four times greater than that of slow fibers (5). Furthermore, it has been suggested that highly specific fast movements could recruit and fire high-threshold motor units (9). In the current study, the weighted bats used in precise combinations significantly increased the bat swing velocity. This may indicate that a greater exertion of muscle force at high speeds is due to a modification of the recruitment pattern of motor units in the central nervous system. Thus perhaps the central nervous system mechanisms that provide for selective activation of the fast motor units in muscle can be specifically trained.

In summary, both training protocols in the present study resulted in significant improvement of hitting velocities. Bat velocity increased significantly more due to the BP protocol than the DS protocol. Therefore, given the findings of this and previous studies, the use of variable weighted bats working in tandem with prescribed training protocols (a combination of heavy/light/standard) significantly increases hitting velocity.

Practical Applications

Since both weighted bat training protocols increased bat swing velocity in college baseball hitters, college coaches have a choice of which protocol to use in their strength training program. For best results they may want to incorporate both into their preseason program. For example, the BP protocol could be included in their on-field preseason practices and the DS protocol in their weight training sessions.

This does not mean we should abandon traditional high resistance training for strength improvement, but rather only that a broader spectrum of weight training methods may be incorporated into the total conditioning program. Weighted implement training is a supplemental resistance training area from which coaches and players can develop additional training protocols.

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