Original Article

Dry swing training with a light bat increases bat speed

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ABSTRACT

Baseball training usually includes dry swing training to improve batting ability. However, no consensus has been reached on the relationship between bat weight and the increase in post-dry swing training bat speed. We hypothesized that dry swing training with a light bat would increase post dry swing training bat speed. Therefore, the purpose of this study was to examine the effect of dry swing training with a light bat on post dry swing training bat speed by comparing a light bat group with a heavy bat group. A total of 34 healthy male students from a university baseball team were randomly divided into a light bat group (n = 17) and a heavy bat group (n = 17). Subjects performed 100 dry swings per day, twice a week for eight weeks. The light bat group performed dry swing training with a 10.6 oz bat and the heavy bat group with a 38.8 oz bat. Bat speed and muscle power were measured before and after the intervention. There was no interaction between the intervention and post dry swing training bat speed, knee extension strength, shoulder horizontal flexion, or hand grip strength. There was a main effect of the intervention on post dry swing training bat speed and shoulder horizontal flexion. Bat speed increased in both groups, but without significant group differences in

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intervention effects. Since light bat loads in this study were very low, dry swing training with a light bat may be more effective and less strenuous. **Keywords:** Baseball; Dry swing; Bat speed; Light load; Plastic bat.

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INTRODUCTION

In baseball batting, a higher bat speed creates a higher momentum, which results in a longer batted ball distance (Adair, 2002). Since batted ball distance is one of the predictors of a baseball players' competition level, bat speed is a very important factor. In baseball training, dry swings with a heavy bat are generally used to increase bat speed.

However, in previous studies, no consensus had been reached on the relationship between bat weight and the increase in post-dry swing training bat speed. De Renne and Okasaki (1983) reported that dry swing training with a heavy bat (34 oz) improved bat speed. Sergo and Boatwright (1993) combined bat weights and compared bat speed post dry swing training between the game bat group (29-31 oz), the heavy bat group (62 oz) and the combination group (heavy bat plus light bat). They found a significant increase in bat speed post dry swing training in all groups, but without group differences. These results show that dry swing training improves bat speed regardless of bat weight. On the other hand, Szymanski et al. (2001) found no significant increase in post-dry swing training bat speed in either the heavy bat group (34 oz) or the light bat group (26 oz). Therefore, while some studies showed that dry swing training improves bat speed regardless of bat weight, other studies found no significant increase in post-dry swing training bat speed regardless of bat weight. No consensus has been reached on the relationship between bat weight and the increase in post-dry swing training bat speed.

On the other hand, it has been reported that post dry swing bat speed (i.e., immediate effects or warm-up indicators) was significantly lower in a heavy bat group (55.2 oz) compared to a game bat group (31.5 oz) (Montoya et al., 2009). It has also been reported that: (i) dry swings with a heavy bat (57 oz) significantly reduced post dry swing bat speed; (ii) dry swings with a game bat (29 oz) did not increase or reduce post dry swing bat speed; and (iii) dry swings with a light bat (6.4 oz) significantly increased post dry swing bat speed (Miller et al., 2017). These findings suggest that dry swings with a light bat, which is extremely compared to a heavy or game bat, increased bat speed more effectively.

The effect of training is based on the accumulation of immediate effects. Since dry swings with a light bat are an effective warm-up, they may increase post dry swing training bat speed. In addition, previous studies examining the effects of dry swing training used heavy bats (≤ 62 oz) and light bats (≤ 26 oz), but they did not examine the effect of dry swing training with a bat much lighter than a game bat. Based on the above findings, we hypothesized that dry swing training with a light bat would increase post dry swing bat speed. Therefore, the purpose of this study was to examine the effect of dry swing training with a light bat on post dry swing training bat speed by comparing a light bat group with a heavy bat group.

MATERIALS AND METHODOLOGY

Participants

A total of 34 healthy male students from a university baseball team were included in this study. The subjects were randomly divided into a light bat group (n = 17) and a heavy bat group (n = 17). The subjects were given both an oral and a written explanation of the purpose of the study and provided written informed consent before enrolment. This study was approved by the Ethics Committee of the School of Comprehensive Rehabilitation, Osaka Prefecture University (approval number: 2017-105).

Measures

(1) Baseline characteristics

Baseline characteristics of the subjects (i.e., age, height, weight, and baseball experience) were recorded.

(2) Bat speed

A multi-speed tester (Red Eyes Pocket, PRGR Co. Ltd., Tokyo, Japan) was used to measure the bat speed of a 31.8 oz metal game bat (Miyaguchi and Demura, 2012). Subjects were orally instructed to perform dry swing while imagining hitting the ball toward centre field without using a ball. A total of ten measurements were performed and the maximum value was used for analysis.

Figure 1. Bat speed

(3) Muscle strength

(a) Knee extension

As a typical measure of the strength of the lower extremity muscle group, the strength of the knee extension muscle group was determined. The Leg Extension (4108a001-91, Cybex International, Inc., Medway, MA) was used for this measurement. The starting limb position was 90 degrees of hip and knee flexion with the distal lower leg on the foot plate. Subjects were orally instructed to minimize trunk movements. The load was set so that the number of repetitions was < 10. Subjects took a one-minute break during load changes. Estimates of maximal strength (one repetition maximum, 1RM) were calculated based on the load and the number of repetitions (Thomas and Roger, 2000).

(b) Shoulder horizontal flexion

The association between shoulder horizontal flexion strength and bat speed has been studied (Miyaguchi and Demura, 2012). In this study, shoulder horizontal flexion strength was measured using a butterfly machine (4022A001-91, Cybex International, Inc., Medway, MA). The starting limb position was 90 degrees of shoulder abduction and external rotation with both forearms on the pads. The load was set so that the number of repetitions was < 10. Subjects took a one-minute break during load changes. Estimates of maximal strength (one repetition maximum, 1RM) were calculated based on the load and the number of repetitions (Thomas and Roger, 2000).

(c) Hand grip
Following the method of Abe et al. (2016), hand grip strength measurement was obtained in one hand, then in the other hand for a total of three measurements in each hand using a hand dynamometer (T.K.K. 5401, Takei Scientific Instruments Co., Ltd., Niigata, Japan). The maximum value was used for further analyses.

Intervention
The light bat group and the heavy bat group performed 100 dry swings per day for two days each week during an 8-week dry swing training period in addition to their usual training. The light bat group used an 8.8 oz plastic bat during the first week and a 10.6 oz plastic bat for the next 7 weeks. Damaged bats were replaced between weeks 1 and 2. The heavy bat group used a 38.8 oz wooden bat during the intervention period. Intervention was performed twice a week for a total of 8 weeks. Research staff monitored training status on all practice days during the intervention.

Analysis
Group comparisons for baseline characteristics were performed using the Student's t-test. A two-way repeated measure analysis of variance (ANOVA) was used to test pre- and post-intervention changes in bat speed and muscle strength. All statistical analyses were performed using IBM SPSS Statistics 25.0 (IBM, Armonk, NY, USA). P-values < 0.05 were considered statistically significant.

RESULTS

Two subjects were excluded from the study due to injuries sustained during non-intervention periods. Sixteen subjects in the light bat group and 16 subjects in the heavy bat group were included in the final measurements. Interventions were ultimately performed 11 times. The participation rates of the light bat group and the heavy bat group were both 87.2%. Table 1 shows the basic characteristics of the two groups. A significant difference between the two groups was found only in height.

Table 1. Baseline characteristics

	Light bat group	Heavy bat group
Age (year)	20.6 ± 1.2	20.9 ± 0.8
Height (cm)	171.7 ± 5.6	176.2 ± 6.5*
Weight (kg)	65.9 ± 6.6	68.4 ± 6.5
Baseball experience (year)	8.9 ± 2.7	9.6 ± 2.7

All values are shown in mean ± SD.
** Values significantly different from Light bat group.*

Table 2 shows pre- and post-intervention changes in bat speed and muscle strength. No interactions were observed between the intervention and bat speed, knee extension strength, shoulder horizontal flexion strength, or hand grip strength although the main effect of the intervention occurred in the measurements of bat speed and shoulder horizontal flexion.

Table 2. Pre- and post-intervention changes in swing speed and muscle power

	Light bat group		Heavy bat group		Main effect (time)	Interaction
	pre	post	pre	post		
Bat speed (km/h)	108.9 ± 14.1	112.4 ± 11.4	114.2 ± 8.7	116.3 ± 7.6	$p < 0.01$	N.S.
Shoulder horizontal flexion (kg)	33.5 ± 8.8	34.0 ± 7.5	32.3 ± 8.7	34.3 ± 7.3	$p < 0.05$	N.S.
Knee extension (kg)	97.5 ± 20.1	100.7 ± 19.4	92.1 ± 16.5	97.3 ± 16.6	N.S.	N.S.
Hand grip (kg)	45.7 ± 6.3	45.4 ± 5.5	44.8 ± 6.2	45.4 ± 4.9	N.S.	N.S.

All values are shown in mean ± SD.
N.S.: Not significant, km: kilometre, kg: kilogram.

DISCUSSION

Bat speed is important for baseball batting. Since higher bat speed increases decision-making time at bat, batted ball speed, and distance (Szymanski et al., 2009; Adair, 2002), it also improves batting ability. The purpose of this study was to examine the effect of dry swing training with a light bat on post dry swing training bat speed.

The results of this study showed that an 8-week training period, which included dry swings with an extremely light bat, increased in post-dry swing training bat speed. The effect of dry swing training with a light bat was equivalent to that with a heavy bat, supporting the claims of Sergo and Boatwright (1993) that bat weight does not affect post dry swing training bat speed. However, a unique finding of this study was that dry swing training using only the light bat, which is extremely light compared to the game bat, increases bat speed.

The force-velocity curve indicated that: (i) the greater the force required for motion, the lower the motion speed; and (ii) the lower the required force, the higher the motion speed (Kreighbaum and Barthels, 1990). Hubbert and Seng (1954) reported that the time required for a dry swing is about 160 ms and that dry swing is a high-speed motion that is completed in a very short time. Therefore, dry swing is a low-load motion, requiring low force regardless of bat weight. It has been reported that low-load and high-speed training increases motion speed (Kaneko et al., 1983; McBride et al., 2002). In addition, McBride et al. (2002) compared a low-load jump squat training group and a high-load jump squat training group and found a significant increase in motion speed and jump height in the low-load jump squat training group. These findings suggest that low-load and high-speed training improves performance by increasing motion speed. Therefore, this study concluded that dry swing training, which is considered a type of low-load and high-speed training, increased bat speed by increasing motion speed.

In addition, we found a significant increase in both bat speed and shoulder horizontal flexion strength after intervention. Increases in the light bat group were equivalent to those in the heavy bat group. A significant positive correlation between shoulder horizontal flexion strength and bat speed has been reported. Therefore, the results of this study also suggest that dry swing training increases shoulder horizontal flexion and bat speed regardless of bat weight.

This study has two limitations. First, it did not measure dry swing speed. Therefore, it is unclear whether dry swing training increases motion speed and bat speed. Secondly, it did not use a control group that did not perform dry swing training. The increase in bat speed found in this study may be due to usual training rather than dry swing training. Future studies are required to further investigate the effect of dry swing training with a light bat on dry swing speed by adding a control group.

CONCLUSIONS

The purpose of this study was to examine the effect of dry swing training with a light bat on post dry swing training bat speed by comparing a light bat group to a heavy bat group. Bat speed in both groups increased after the long-term interventions. It was found that dry swing training with a light bat increases bat speed, and the effect was equivalent to that with a heavy bat. The dry swing load with a light bat was significantly lower than that with a heavy bat, indicating dry swings with a light bat is light training. Therefore, the results of this study suggest that training with a light bat is less strenuous and therefore more effective.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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