

# EFFECT OF AN 8-WEEK COMBINED WEIGHTS AND PLYOMETRICS TRAINING PROGRAM ON GOLF DRIVE PERFORMANCE

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**ABSTRACT.** Fletcher, I.M., and M. Hartwell. Effect of an 8-week combined weights and plyometrics training program on golf drive performance. *J. Strength Cond. Res.* 18(1):59–62. 2004.—The purpose of this study was to determine the effect of a combined weights and plyometrics program on golf drive performance. Eleven male golfers' full golf swing was analyzed for club head speed (CS) and driving distance (DD) before and after an 8-week training program. The control group ( $n = 5$ ) continued their normal training, while the experimental group ( $n = 6$ ) performed 2 sessions per week of weight training and plyometrics. Controls showed no significant ( $p \geq 0.05$ ) changes, while experimental subjects showed a significant increase ( $p \leq 0.05$ ) in CS and DD. The changes in golf drive performance were attributed to an increase in muscular force and an improvement in the sequential acceleration of body parts contributing to a greater final velocity being applied to the ball. It was concluded that specific combined weights and plyometrics training can help increase CS and DD in club golfers.

**KEY WORDS.** complex training, sequential acceleration, specificity, amortisation phase

## INTRODUCTION

Physical fitness is viewed as a key component for optimum performance in almost every sport. By comparison, golf has traditionally focused on the technical, tactical, and mental aspects of the game (10). However, recently an increase in the level of conditioning of a number of top professional players, and the increase in the distance players can drive, has made golf conditioning of interest to many coaches and players. This is of particular relevance when we look at the clear physical differences between professional tour players and amateur golf players. Professionals are able to rotate faster in their swing (14), while amateurs are less efficient in their loading patterns (i.e., sequential acceleration), possibly due to inferior swing mechanics and physique (10). Thus, professionals can generate greater club head speed in their full swing driving action, a factor which appears vital in obtaining maximum distance from the tee. These physical factors would seem to be vulnerable to change with appropriate conditioning programs and could have a positive effect on golf performance.

The technical aspects of a full golf swing are well established (9, 19) and vital; as Leadbetter (9) states, the correct linkage of various components of your body with your hands and club produces dynamic motion, with the torso controlling the direction and speed of the club head. The segmental sequence that makes up the golf swing is recognized to be the movement of the hips followed by the

trunk, shoulders, arms, and hands (in the back swing). The down swing leads with the hips, trunk, shoulders, arms, hands and finally the club head go through sequential acceleration (3, 5) to arrive at the high velocities required at the club head to propel a ball maximum distances with control. The lower limbs act as stabilizers to allow torque to be applied to the club head, helped by the change from large body parts accelerating slowly, to smaller body parts accelerating more and more quickly (19). This has been likened to the process of coiling the body (back swing) followed by an unwind (down swing) (9).

Three main factors affect club head speed (CS): muscular force applied through the limb segments, the distance over which the force acts, and the segmental sequence which contributes to the final velocity (12). These factors (in other sports) seem to be prone to changes through training, which (if applicable to golf) could result in greater CS and driving performance. Indeed, as Hetu et al. (7) has stated, the importance of conditioning for golfers cannot be overemphasized as it may enhance driving performance by increasing CS.

Despite the possibility of performance enhancement, golfers refrain from strength and conditioning exercises in fear they will reduce their range of motion (ROM) and cause muscle stiffness, which they maintain will cause a decrease in performance (1). Examples from other sports do not support this supposition. Javelin throwers, for example, have tremendous musculature and use a great deal of resistance work as part of their training, but still manage to have a far greater ROM around the shoulder girdle and torso than a golfer would ever need.

Many studies have shown that resistance work will result in the ability of individuals to generate greater muscular force (6, 17, 20, 22, 23); however, the argument on what resistance training to incorporate is interesting. Golf swing performance is related to the segments of the body applied to the club head in order to hit the ball. If you lead with the hips, trunk, and then shoulder, the movement adheres to the summation of speed principle and therefore greater torque being applied to the club through the eccentric/concentric sequence of spinal rotators (3, 5). The action of the golf drive can then be classified as a stretch shortening movement, which would be grouped as a plyometric action, because of the limited transition time between the eccentric (back swing) work and the concentric (down swing) action. With this in mind, the evidence strongly suggests that plyometric training (16, 22) or combined weights/plyometrics (4, 11)

**TABLE 1.** Resistance and plyometric training protocols.

Resistance exercise	Equipment	Sets/reps	Medicine ball exercise	Sets/reps
Bench press	Olympic bar	3 × 6/8 reps	Seated horizontal	3 × 8 reps
Squat	Olympic bar	3 × 6/8 reps	Twists	
Single arm row	Dumbbell	3 × 6/8 reps	Standing horizontal	3 × 8 reps
Lunge	Olympic bar	3 × 6/8 reps	Twists	
Shoulder press	Dumbbell	3 × 6/8 reps	Standing back	3 × 8 reps
Upright row	Dumbbell	3 × 6/8 reps	Extensions	
Abdominal crunch	Dumbbell	3 × 6/8 reps	Golf swings	3 × 8 reps
Back extension	Dumbbell	3 × 6/8 reps		
Side bends	Dumbbell	3 × 6/8 reps		

is the best form of resistance work to produce superior performances in this type of plyometric action. Incidentally, this type of training appears not to cause the excessive hypertrophy that many golfers are concerned about.

Does resistance training cause changes in full golf swing mechanics and lead to increased drive performance, particularly when we consider the high level of technique and coordination needed to successfully propel a ball down a fairway? Few studies have investigated the effects of resistance training on golf performance, but each has shown a significant impact on increasing CS. Lennon (10) used controlled weight training studies, while Hetu et al. (7) used a combined plyometric and weight training study (though with no control). The aim of this study was to see the effect of a specific combined weights/plyometric conditioning program on golf drive performance in club standard players.

## METHODS

### Experimental Approach to the Problem

Two groups (control and experimental) performed a pre- and posttraining designed intervention in which CS and driving distance (DD) were recorded.

The control group continued their normal training, while the experimental group completed a combined weights and plyometrics program to see whether this type of training modality would have a positive or negative or no effect on golf CS and DD.

Reliability was assessed using a coefficient of variation on pretest measures. A good level of reliability was observed, with a mean coefficient of variation for all subjects of 1.2% for CS and 4.8% for DD.

### Subjects

Eleven male golfers volunteered to participate in the study. Subjects mean  $\pm$  SD for age, height, and body mass were  $29 \pm 7.4$  years,  $179.3 \pm 5.4$  cm, and  $76 \pm 6.8$  kg. Subjects mean golf handicap was  $5.5 (\pm 3.7)$ , (classified as a very good club standard golfer). The procedures used were approved by a departmental committee for ethics research. Subjects were required to read and complete a health questionnaire and informed consent document; there was no history of coronary heart disease, diabetes or recent surgery.

Sample size was estimated by Eq. 1 (8):

$$n = 8s^2/d^2 \quad (1)$$

where  $s$  = typical error and  $d$  = confidence limits. Sample size estimates were 5 for CS and 8 for DD.

Subjects were regular club golfers who had partici-

pated in unsupervised exercise programs within the past 6 months. Subjects were randomly assigned to 2 groups. The experimental group ( $n = 6$ ) participated in a supervised resistance/plyometric training program, the control ( $n = 5$ ) carried on with their regular training (mainly aerobic exercise with some light machine weights). No subject had participated in a similar conditioning program at any time.

### Testing

All subjects were assessed before and after an 8-week training program. Testing was carried out (after a familiarization session) 1 week prior and 1 week after the program. CS was assessed using *Golftex Prografix for Windows* using the pro-swing analyzer. A PF-123 program was used to analyze the golf swing.

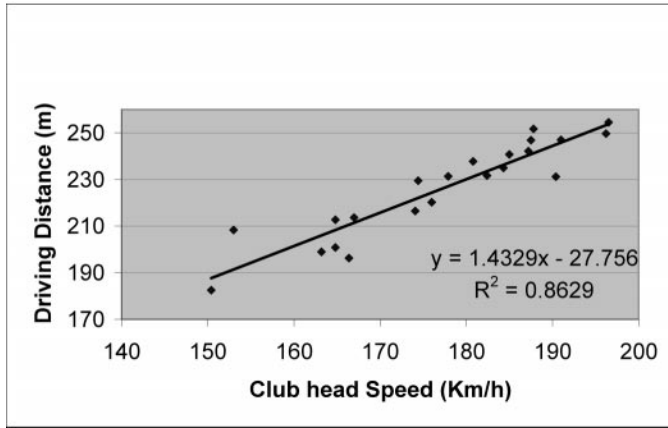
Each subject had 5 attempts to drive the ball as far as possible with their own driver, using their normal driving swing. The distance the ball carried was measured using a series of preset markers and a tape measure. The same driving range, club, model, and compression of ball was used in the pre- and posttraining measurements.

### Training

The 8-week training program consisted of free weight training exercises and specific medicine ball work (Table 1). Prior to the start of training, the experimental group was instructed on the correct lifting techniques. The training program required the subjects to train for 90 minutes 2 times per week on nonconsecutive days. Each day consisted of free weight resistance work (3 sets of 6–8 reps) and plyometric medicine ball (3 kg) work (3 sets of 8 reps). A standardized warm-up and cool-down was used in each training session. This consisted of 10 minutes pulse raising and mobilizing/dynamic flexibility activities performed in a light circuit mimicking the movement patterns to be performed in the program (warm-up) and 5 minutes low-level cycling followed by a total body static stretch routine (1 set of 12 seconds per muscle group) for the cool-down. The resistance exercise was performed in a controlled manner until failure. The starting point for each exercise was 3 sets of 6 reps; when  $3 \times 8$  reps could be achieved, the resistance was increased by 5 kg. The plyometric medicine ball exercises (3 kg) were performed in an explosive manner, mimicking the golf swing action as closely as possible. With this in mind, the medicine ball was released at the end of each movement in an attempt to maximize the sequential acceleration of the movements chosen. Each subject kept a personal training log; all training sessions were supervised by a qualified fitness instructor.

**TABLE 2.** Mean ( $\pm$ SD) scores for club head speed and driving distance for control and experimental groups.

	Control			Experimental		
	Pre	Post	Change (%)	Pre	Post	Change (%)
Club head speed (km·h)	172.3 $\pm$ 17.1	173 $\pm$ 18.7	0.5	179.8 $\pm$ 9.1	182.6 $\pm$ 6.2	1.5
Driving distance (m)	220.8 $\pm$ 19	219.3 $\pm$ 30.7	-0.7	225.6 $\pm$ 16	235.7 $\pm$ 11.4	4.3

**FIGURE 1.** The relationship between golf club head speed and driving distance ( $n = 22$ ).

### Statistical Analyses

A mixed model repeated measures analysis of variance (ANOVA) was used to determine interactions between the trial (pre and post) and group (experimental and control) test results. Posthoc analysis was carried out using least significant difference (LSD). Statistical analysis was carried out using SPSS for windows. Pearson product-moment correlation coefficient was computed to determine the interrelationships between CS and DD. The level of significance for both statistical tests was set at an alpha level of  $p \leq 0.05$ .

### RESULTS

Table 2 shows the mean scores and percentage changes for club head speed and driving distance for the control and experimental groups. The repeated measures ANOVA showed no significant changes between pre- and post-training scores for CS ( $p \geq 0.05$ ) or DD ( $p \geq 0.05$ ) for controls. However a significant difference was shown between the pre- and posttraining scores for CS ( $p \leq 0.05$ ) and DD ( $p \leq 0.05$ ) for the experimental group.

Figure 1 shows a scatterplot between CS and DD ( $p \leq 0.05$ ), using the pre- and posttest data combined ( $n = 22$ ).

### DISCUSSION

The main findings from this study were a significant increase in golf DD and CS ( $p \leq 0.05$ ) following an 8-week combined weight training and plyometric conditioning program. When confidence intervals (95% CI) were computed they showed the true increase in club head speed to be between 0.7 and 2.7  $\text{km}\cdot\text{h}^{-1}$ , while the true increase in driving distance lay between 5.1 and 17.3 m. In addition, changes in CS have been shown to be associated with changes in DD ( $p \leq 0.05$ ; Figure 1).

This change in CS from resistance training has been reported by Hetu et al. (7); only Lennon (10) has reported

an increase in DD following a period of resistance training. A number of factors may contribute to a change in DD, including an increase in muscular force, an increase in the distance forces act over, an increase in the number of body segments brought into action, and better sequential acceleration contributing to a greater final velocity (12).

The training program in this study was designed to affect muscular force (weights and medicine ball work) and to help the sequential nature of a golf swing (medicine ball plyometric work), while maintaining the distance forces act over (maintenance stretching). Each of these training modalities has been shown to be effective in isolation. Weight training can increase muscle force output by increasing muscle cross sectional area (though this is unlikely over an 8-week program of this type) and by enhancing motor unit recruitment (6, 23). The rationale for plyometrics is that by initiating a prestretch followed by a shortening of the amortization phase between eccentric and concentric muscle contraction, increases in power may be gained (16). The plyometric exercises in the training program were designed to mimic the prestretch during the back swing in golf, activating the arm extensors and shoulder abductors, stimulating proprioceptors to facilitate an increase in motor unit recruitment over a minimal timeframe (2). Therefore, stored elastic energy helped by muscle stiffening (prestretch) may cause an increase in total work performed in the concentric phase (down swing) of a golf swing. However, the combination of both training modalities (complex training) may be more effective in increasing force production than isolating these training modalities. According to Chu (4), complex training causes changes in the musculotendinous system and the neuromuscular system, helping slow twitch fibers to take on fast twitch characteristics. Lyttle et al. (11) supports this argument when comparing maximum power training and a combined weights and plyometrics program. They found significant improvements in both modalities, but concluded that the combined training tended to produce superior performances in stretch shortening movements.

An area of concern for many golfers is the belief that resistance training will negatively affect their flexibility and therefore their swing mechanics. In this study (although flexibility was not measured), subjects reported no detrimental effects to their swing mechanics or drive accuracy, while Hetu et al. (7) found that an increase in ROM was possible when a flexibility program was combined with resistance work. The possibility of ROM being affected by hypertrophy was not investigated, though body weight was taken pre- and posttraining, negligible changes were found. The work of Staron et al. (18) found, that though strength was increased over an 8-week resistance program, muscle cross-sectional area increases were not significant. They concluded that though hypertrophy may have a role in early phase resistance training, neural adaptations have a more important impact.

To conclude, it appears that a specific complex training regimen can help increase CS and DD. It may be an important part of a conditioning program to help increase golf drive performance for club standard golf players.

## PRACTICAL APPLICATIONS

Golf drive performance can be improved by a combination of resistance and plyometric training, even over the relatively short time span of 8-weeks, (involving 16 sessions). However, it must be emphasized that the specific nature of many of these exercises is important to incorporate into a conditioning program. The weight training exercises were designed to strengthen the golfer's whole body, as strong arms and hands are needed to deliver the club face squarely to the ball (10) and the legs and torso need strength to maintain stability throughout the swing (19). They were fairly simple lifts (as these were not experienced lifters). This gave a base for the specific medicine ball work exercises, which were designed around elements of the golf swing (e.g., take away, forward swing, acceleration, early follow-through, and late follow-through) (21). They combined the use of a stable lower body and an active torso and arms (10). This allowed the sequential acceleration of body parts to achieve a maximum power output on release of the ball. Newton et al. (15) showed an increase in velocity of movement, force output, and electromyogram when a bar is released in the bench press vs. a normal press movement. The sequential nature of the medicine ball work is vital. Enoka (5) states that an increase in shoulder acceleration in the direction of the ball will tend to accelerate the club in the same direction resulting in greater torque being applied to the golf club in the down swing. Importantly, the sequential acceleration of hips, shoulders, elbows, and hands should be mimicked in the medicine ball work; this is helped by the release of the ball (10). If the medicine ball is not released, the golfer may learn to decelerate in the latter stages of the swing rather than accelerating through the ball.

It must be remembered that this is an observation of the early phase of training (8 weeks). Whether the long-term training effect would be a more complete muscle adaptation has not been demonstrated.

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