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# Effects of Combined Training for 8 Weeks on EMG and Driver Distance in Obese Women Pro-Golfers

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***Abstract***

*The purpose of this research study was to investigate the effect of improving factors related to obesity and enhanced physical strength through combined training on driver distance and athletic performances. We analyzed the effects of 8 weeks of combined training on body composition and 1 repetition maximum (1RM), muscle activations, and driver distance in 11 Korean women pro-golfers without medical conditions. In considering the effects of combined training, we measured body composition and 1RM, and muscle activation and driver distance before training (0 week) and after training (8 weeks). There were significant differences in body fat percentage, fat-free mass, and 1RM ($p<.001$) before and after training. There was also a significant increase in driver distance ($p<.05$). Upon representing a percentage of maximum force of golf swing in proportion to the reference voluntary contraction (RVC), muscle activation of the external oblique, and latissimus dorsi were significantly increased($p<.05$).*

***Keywords:*** *Obesity, Women golfer, Combined training, Driver distance, EMG*

## 1. Introduction

Golfers need an effective golf swing to enhance driver distance performance in a golf competition and this should be prioritized over anything else. Recently, some researchers have recently emphasized that muscular strength training is important in order to enhance golf athleticism and driver distance performance, which includes improving physical factors such as flexibility, strength, and power [1][2]. Nevertheless, golfers still have a low level of awareness of the importance of muscular strength training. Most preceding studies have mainly focused on an effective golf swing, and a great deal of research on the technological and psychological factors assume the major ratios [3]. The golf swing is performed through muscle relaxation and contraction of various muscles in different combinations. EMG analysis-based research indicates that the trunk rotation required for the golf swing places pressure on the vertebra and vertebrae lumbales, which inflicts injury to the vertebrae in those who lack good muscular strength or flexibility [4]. Additionally, one study reports that training programs are necessary to reduce the injuries from golf and enhance athletic performance, and improved swing skills in addition to physical strength programs reduce the risk of injuries and contribute to reinforcing overall athletic performance in golfers [5]. Thus, this research study investigated the effects of improving factors related to obesity and

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enhanced physical strength through 8 weeks of combined training on driver distance and golf performance in Korean women pro-golfers with obesity.

## 2. Materials and methods

### 2.1. Study participants

Participants included obese Korean women from 20-3- years old who were professional golfers without any medical condition. Participants were > 30% body fat. By this criterion, a total of 14 women were enrolled in this study. Below is the characteristic of the participants [Table 1].

Table 1. Physical characteristics of participants

| N | Age (yr) | Height (cm) | Weight (kg) | Body fat (%) | Lean body mass (kg) |
|---|---|---|---|---|---|
| 11 | 27.36±0.75 | 162.68±1.08 | 61.85±1.40 | 33.50±0.65 | 41.08±0.79 |
| *Values are given as means ± S.E* | | | | | |

### 2.2. Preliminary testing

Height and body fat percentage were measured by the Inbody 220 Body Composition Analysis, which uses electric resistance to determine body composition. Five strength training machines (lat pull down, shoulder press, leg curl, leg extension, and adductor; Cybex, USA), were used to examine maximum muscle power of the upper and lower body for determining 1-repetition maximum (1RM). Driving distance was measured using the FlightScope X2 (EDH, USA) program.

### 2.3. Training program

Combined exercise training including weight training and plyometric training was performed three times a week for 8 weeks. Weight training included the performance of the following exercise: dumb-bell press, dumb-bell thruster, kettle-bell press, kettle-bell sumo deadlift, sit-up, and squat, among others. For plyometric training, the tuck-jump, burpee, plyo push up, and jump-squat were performed. The type and intensity of exercise were increased gradually over 8 weeks of training.

### 2.4. EMG testing

For measuring muscle activity, a wireless surface EMG electrode (Trigno Wireless System, USA) was used. EMG data was analyzed using EMG analysis software (EMG Works Analysis 4.0, USA). To measure %RVC, after three-time repeat analysis of the same motion for each part, the participants swung three times. The swing motion was divided into four phases. The first phase is address, the second is back swing top, the third is impact, and the fourth is the finish. Phases were then divided into two sections. The first section is from down swing to the point of impact, and the second section is from the point of impact to the follow through [Table 2] and [Table 3].

### 2.5. Statistical analyses

Data are presented as means ± standard error (SE). Significant differences among mean values between pre- and post-training, were determined by paired t-test using SPSS 21.0 for Windows. Statistical significance was set at p=0.05.

Table 2. Location for EMG attachment

| | Right | Left |
|---|---|---|
| The Upper Body | External oblique | Posterior deltoid |
| | | Latissimus dorsi |
| The Lower Body | Biceps femoris | Gluteus medius |
| | | Vastus lateralis |

Table 3. Measured motions

| Measuring Parts | Motions |
|---|---|
| External oblique | Lie supine, bend legs at an angle of 45°, and bring the right elbow to touch the left knee. |
| Posterior deltoid | Bend the waist at an angle of 90° and straighten both knees, and make straight line shoulder and back of hands. |
| Latissimus dorsi | Bend the waist at an angle of 90° and straighten both knees. Pull up the left elbow while facing the dorsal aspect of the hand outward. |
| Biceps femoris | Stand up straight, and bend right leg toward back side until making 90. |
| Vastus lateralis | Sit on the chair with both knees at right angles. Raise the leg and make a straight line with leg. |
| Gluteus medius | Lie on one side and straighten both legs. Create a straight line with the whole body. Raise the left leg up to 45 cm without bending. |

## 3. Result

### 3.1. Change in body composition

[Table 4] shows the results of the paired t-test conducted to determine the change in body composition. Body fat percentage declined from 33.50±0.65 percent before training (0 weeks) to 30.04±0.55 percent after training (8 weeks) while fat-free mass significantly increased from 41.08±0.79 before training (0 weeks) to 45.38±0.94 after training (8 weeks) ($p<.001$).

Table 4. Changes in body composition

| | Body weight (kg) | Body fat (%) | Lean body mass (kg) |
|---|---|---|---|
| Pre (0 weeks) | 61.85±1.40 | 33.50±0.65 | 41.08±0.79 |
| Post (8 weeks) | 61.28±1.40 | 30.04±0.55 | 45.38±0.94 |
| t-value | 1.021 | 14.799** | -12.069** |

Values are given as means ± S.E., ***p*<.001.

### 3.2. Change in 1RM and driver distance

Table 5 shows the results of the paired t-test conducted to evaluate the change in 1RM based on exercise machine performance and driver distance. There was an increase in all values after training, with statistically significant differences compared to before training ($p<.001$, $p<.05$).

Table 5. Changes in 1RM and driver distance

| | Adductor (kg) | Leg curl (kg) | Leg extension (kg) | Lat pull down (kg) | Shoulder press (kg) | Driver distance (m) |
|---|---|---|---|---|---|---|
| Pre (0 weeks) | 36.82±2.36 | 33.18±1.94 | 43.64±1.66 | 29.55±1.25 | 16.82±0.76 | 188.00±4.56 |
| Post (8 weeks) | 43.73±1.74 | 39.18±1.15 | 49.36±1.95 | 34.18±0.86 | 19.55±0.82 | 194.64±3.58 |
| t-value | -6.239** | -6.708** | -4.944** | -5.671** | -4.512** | 2.340* |

*Values are given as means ± S.E., **p<.001, *p<.05.*

## 3.3. Change in EMG

### 3.3.1. RVC

[Table 6] shows the result of the paired t-test conducted to evaluate the differences in muscle activation during RVC movement before training (0 weeks) and after training (8 weeks). We found a significant increase in latissimus dorsi activation from 0.025±0.003 mV before training (0 weeks) to 0.035±0.002 mV after training (8 weeks) during RVC movement ($p<.05$). Additionally, there was a significant increase in vastus lateralis EMG activity during RVC movement from 0.029±0.003 mV before training (0 weeks) to 0.055±0.009 mV after training (8 weeks) ($p<.05$).

Table 6. Change in RVC movement

| RVC (mV) | Biceps femoris | External oblique | Gluteus medius | Latissimus dorsi | Posterior deltoid | Vastus lateralis |
|---|---|---|---|---|---|---|
| Pre (0 weeks) | 0.022±0.002 | 0.032±0.004 | 0.044±0.002 | 0.025±0.003 | 0.059±0.009 | 0.029±0.003 |
| Post (8 weeks) | 0.027±0.003 | 0.025±0.002 | 0.050±0.004 | 0.035±0.002 | 0.063±0.008 | 0.055±0.009 |
| Pre-post %RVC | +22.73% | -21.88% | +13.64% | +40.00% | +6.78% | +89.66% |
| t-value | -1.604 | 1.472 | -1.550 | -2.345* | -0.886 | -3.748* |

Values are given as means ± S.E., *$p<.05$.

### 3.3.2. Golf Swing

[Table 7] show the result of the paired t-test conducted to evaluate the differences golf swing performance before and after training, represented by the proportion of maximum muscle activation during the golf swing to muscle activation during RVC movement by percentage. We found that, during the swing, external oblique muscle activation significantly increased to 151.52±20.28 and 73.4% in proportion to the RVC measured value ($p<.05$). Additionally, latissimus dorsi activation during the swing after training was 173.33±22.41 mV, which was significantly increased by 33.33% in proportion to the RVC measured value ($p<.05$).

Table 7. Change in % RVC value during golf swing

| Golf swing (%) | Biceps femoris | External oblique | Gluteus Medius | Latissimus dorsi | Posterior deltoid | Vastus lateralis |
|---|---|---|---|---|---|---|
| Pre (0 weeks) | 143.18±29.02 | 102.27±12.21 | 122.73±8.62 | 112.12±9.29 | 133.37±31.01 | 127.88±14.70 |
| Post (8 weeks) | 203.79±27.78 | 151.52±20.28 | 119.95±16.78 | 173.33±22.41 | 124.32±35.04 | 92.26±9.96 |
| t-value | -1.702 | -2.382* | -0.193 | -2.338* | 0.188 | 1.834 |

*Values are given as means ± S.E., *p < .05.*

## 4. Discussion

Obesity is known to reduce athletic performance and heighten the risk of injury. Thus, the importance of muscular strength training is emphasized to prevent obesity [6]. In the same context, this research study involved 8 weeks of combined training with the aim to address a problem in obese women pro-golfers and increase driver distance performance. It is indicated that after 8 weeks of combined training, body fat percentage fell by 10.33% compared with that before training (at 0 weeks), showing statistically significant differences (p<.001). Regarding fat-free mass, an increase of 11.17% was exhibited after 8 weeks of combined training compared with that before training (at 0 weeks), showing statistically significant differences (p<.001).

Our result proves that combined training decreases body fat mass and increases fat-free mass, which has a positive effect on body composition [7]. In this study, a comparison between 1RM before training (0 weeks) and after training (8 weeks) was made. We found an increase in strength with the following exercise: adductor (18.77% increase), leg curl (18.08% increase), leg extension (13.11% increase), lat pull down (15.67% increase), and shoulder press (16.23% increase), making statistically significant differences (p<.001).

It can be concluded that this corresponds to an improvement of muscular strength in left extension, left flexion, right extension, right flexion, back muscle extension, and abdominal muscle flexion after 12 weeks of muscular strength training, showing statistically significant differences [8].

Regarding driver distance performance after 8 weeks of combined training, we also found that muscular strength increased 3.53% after training (8 weeks) compared with before training (0 weeks), making statistically significant differences. It can be concluded that combined training elicits an improvement in driver distance performance [9]. In this regard, we used EMG measurements to demonstrate of its influence on driver distance performance. Through EMG analysis, muscle activation in RVC and golf swing movements before and after combined training was measured. A comparative analysis of the change in muscle activation, represented by maximum muscle activation during golf swing in proportion to muscle activation measured during RVC movement by percentage, was conducted. An increase of 40% (p<.05) of the latissimus dorsi activity during RVC movement after training (8 weeks) compared with before training (0 weeks) was exhibited. There was also an increase of 89.66% (p<.05) in vastus lateralis activity.

According to the research analysis for muscle activation during the golf swing in proportion to RVC movement, there was an increase in muscle activation to 40% (p<.05) after training (8 weeks) compared to that before training (0 weeks). There was an increase of

 

89.66% in vastus lateralis activity. This corresponds to an analysis of the relationship between muscular strength and club head speed. It is reported that trunk power, hand grip strength, and normalized leg and hip power play a central role in helping elite golfers (HCP<3) increase head speed. In particular, trunk power is most closely correlated with head speed. In this regard, it is deemed that, according to the research result, the more muscle activation in the latissimus dorsi and external oblique, the better the driver distance.

## 5. Conclusion and suggestion

In conclusion, this research study shows that the reduction of body fat after 8 weeks of combined training has improved the factors of obesity. It is considered that the rise in fat-free mass, 1RM, and muscle activation of the trunk, core, and arms has exerted a positive effect on the increase of driver distance and golf performances. However, this research study is limited in its small sample size, with participants of a specific population (women pro-golfers with obesity) and no control group, which does not allow for an accurate comparison.

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