# Effects of Kettlebell Training on Aerobic Capacity

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## Abstract

Falatic, JA, Plato, PA, Holder, C, Finch, D, Han, K, and Cisar, CJ. Effects of kettlebell training on aerobic capacity. *J Strength Cond Res* 29(7): 1943–1947, 2015—This study examined the effects of a kettlebell training program on aerobic capacity. Seventeen female National Collegiate Athletic Association Division I collegiate soccer players (age: 19.7 ± 1.0 years, height: 166.1 ± 6.4 cm, weight: 64.2 ± 8.2 kg) completed a graded exercise test to determine maximal oxygen consumption ($\dot{V}O_2$max). Participants were assigned to a kettlebell intervention group (KB) ($n = 9$) or a circuit weight-training (CWT) control group ($n = 8$). Participants in the KB group completed a kettlebell snatch test to determine individual snatch repetitions. Both groups trained 3 days a week for 4 weeks in addition to their off-season strength and conditioning program. The KB group performed the 15:15 $MVO_2$ protocol (20 minutes of kettlebell snatching with 15 seconds of work and rest intervals). The CWT group performed multiple free-weight and dynamic body-weight exercises as part of a continuous circuit program for 20 minutes. The 15:15 $MVO_2$ protocol significantly increased $\dot{V}O_2$max in the KB group. The average increase was 2.3 $ml \cdot kg^{-1} \cdot min^{-1}$, or approximately a 6% gain. There was no significant change in $\dot{V}O_2$max in the CWT control group. Thus, the 4-week 15:15 $MVO_2$ kettlebell protocol, using high-intensity kettlebell snatches, significantly improved aerobic capacity in female intercollegiate soccer players and could be used as an alternative mode to maintain or improve cardiovascular conditioning.

**Key Words** aerobic conditioning, interval training, $\dot{V}O_2$

## Introduction

In the past decade, kettlebell (KB) training has gained popularity in the United States and become a viable option for strength training and conditioning. Kettlebells are an ideal tool for ballistic full-body exercises using high muscle forces, making them potentially useful for improving muscular strength and cardiorespiratory fitness (11). Studies have examined the cardiovascular and metabolic effects of a kettlebell workout (1,2,5,10,13,16). Specifics of the workout routines have varied (i.e., kettlebell weight, exercises, sets, repetitions, duration, and rest); however, most results indicate that the intensity is sufficient to improve cardiorespiratory fitness. Performing 12 minutes of continuous kettlebell swings provided a metabolic challenge of sufficient intensity, 87% of maximal heart rate ($HR_{max}$) and 65% of maximal oxygen consumption ($\dot{V}O_2$max), to increase aerobic capacity (4), with gains greater than that seen with traditional circuit weight training (CWT). Similar results have been reported with interval kettlebell training. Using the kettlebell snatch, clean to press, and swing, heart rates averaged 88% of age-predicted $HR_{max}$ and 90% of $\dot{V}O_2$max during three 6-min cycles of 30 seconds of work and rest intervals (5). During the workout, perceived exertion was rated as hard (15 on the Borg's 6-20 scale). Using multiple 5- to 7-minute cycles of 9 kettlebell exercises performed at a self-selected pace, $\dot{V}O_2$ and HR were comparable with commonly used modes of aerobic exercise, such as incline walking, stationary cycling, and running (2). Jay (11) developed a conditioning protocol designed to improve aerobic capacity that uses high-intensity kettlebell snatch intervals. Dubbed the 15:15 $MVO_2$ protocol, it involves multiple sets of 15 seconds of kettlebell snatching alternating with 15 seconds of rest. Average heart rate was 93% of $HR_{max}$ and oxygen consumption was 78% of $\dot{V}O_2$max when performing the 15:15 $MVO_2$ protocol for 20 minutes (16–17). According to the American College of Sports Medicine, exercise intensities between 77 and 90% of $HR_{max}$ or above 40–50% of oxygen uptake reserve are sufficient to improve cardiorespiratory fitness (20). Thus, the 15:15 $MVO_2$ protocol should improve aerobic fitness and increase $\dot{V}O_2$max.

Higher exercise intensities have been shown to elicit greater improvements in $\dot{V}O_2$max than lower exercise intensities (6). High-intensity interval training (HIIT) requires working at or near maximal intensity for shorter periods. Interval running at 90–95% of $HR_{max}$ improved $\dot{V}O_2$max in untrained and moderately trained individuals more than training at 70–80% of $HR_{max}$ (9,19). Similarly, performing HIIT programs on a cycle ergometer at supramaximal

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intensities (120–170% $\dot{V}O_2$max) increased aerobic capacity more than low-intensity continuous work (7,18). Enhancing aerobic capacity through HIIT can also lead to improvements in athletic performance. After 4 weeks of HIIT, well-trained rowers significantly improved their 2,000 m times, (3) whereas cyclists improved their 40-km time trials (14). Additionally, HIIT increased the aerobic capacity of soccer players and enhanced multiple variables of soccer performance (8).

Although many kettlebell workouts incorporate work and rest cycles consistent with HIIT and intensities sufficient to improve aerobic capacity, to our knowledge, only 1 study has measured changes in aerobic capacity resulting from a kettlebell training program. Jay et al. (12) measured aerobic training effects in relatively inactive individuals with neck and low back pain. Participants performed 10 repetitions of kettlebell swings and deadlifts with 30–60 seconds of rest between sets, 3 days a week for 8 weeks. Kettlebell weight or repetitions were progressively increased. There were significant reductions in neck, shoulder, and low back pain compared with an inactive control group; however, there was no change in $\dot{V}O_2$max, measured using Åstrand's submaximal cycling test.

Although Schnettler et al. (17) reported that the 15:15 $MVO_2$ protocol elicits intensities sufficient to improve $\dot{V}O_2$max, no studies have examined the effects of this training protocol on aerobic capacity. The kettlebell snatch is a common exercise used by those who regularly train with kettlebells and has considerable carryover to physical activities such as running and jumping (21). Thus, this form of training may be appropriate for athletes and provide an alternative mode of exercise to enhance aerobic capacity. During the snatch, the kettlebell travels from between an individual's legs to a lockout position above the head. This motion is reversed and repeated at a rapid pace, increasing the velocity that the kettlebell travels. As velocity increases, power output increases, resulting in a higher caloric expenditure and oxygen consumption (11). The purpose of this study was to examine the effects of a high-intensity 4-week kettlebell training program on aerobic capacity in collegiate female soccer athletes. It was hypothesized that the kettlebell training program would increase aerobic capacity, with gains greater than that observed in a CWT control group.

## Methods

### Experimental Approach to the Problem

To evaluate the effects of the kettlebell training program on aerobic capacity, athletes were assigned to a KB training group or a CWT control group. Aerobic capacity was measured during a maximal graded exercise test (GXT) on a bicycle ergometer before and after the 4-week training program. Eighteen female collegiate soccer players were recruited as participants and assigned to either the KB or CWT group. Athletes in the KB group implemented a kettlebell protocol as part of an off-season workout, whereas athletes in the CWT group followed a typical strength and conditioning program. Kettlebell training was conducted 3 days per week for 4 weeks.

### Subjects

All subjects were on the roster of a National Collegiate Athletic Association Division I collegiate women's soccer team; 21 athletes were eligible to participate. Approval was obtained from the University's Institutional Review Board for Human Subjects, and all athletes provided written consent and an updated medical history before testing. Within the year, all athletes had undergone a medical examination and were cleared for athletic participation. Two athletes had injuries that prevented pretesting; a third athlete sustained an injury after completing the pretesting. Thus, 18 athletes were assigned to a training group. Those assigned to the KB group ($n = 10$) demonstrated safe and efficient technique when performing the kettlebell snatch. This was assessed by a Russian Kettlebell Certified Strength and Conditioning Specialist (RKC/CSCS). Athletes not selected for the KB group were assigned to the CWT group ($n = 8$). All athletes frequently trained with kettlebells as part of their seasonal strength and conditioning program, although the kettlebell snatch was not an exercise routinely implemented. One athlete in the KB group completed the training sessions but sustained an injury before the posttest. She was cleared to participate, but during the posttest, she reported symptoms, and the GXT was stopped before she reached maximal effort. Because of this, her data were excluded from the analyses. Thus, data are reported for 17 participants, 9 in the KB group and 8 in the CWT group.

### Procedures

*Test Session 1.* During the first test session, weight and height were measured using a platform scale and stadiometer, respectively. Aerobic capacity was measured during a maximal GXT using an Ultima metabolic cart (Medical Graphics Corp., St. Paul, MN, USA) and a Lode Excalibur electronic cycle ergometer. Heart rate and rhythm were monitored from a 12-lead electrocardiogram (ECG). Seat height was adjusted parallel to the participants' greater trochanter while standing next to the cycle ergometer. Resting blood pressure and ECG were recorded while seated on the ergometer. Athletes were connected to the metabolic cart by an airtight facemask fitted with a pneumotach and sampling line. Ventilation and oxygen and carbon dioxide concentrations in the expired air were measured with each breath. Subjects selected a comfortable pedaling rate and were encouraged to maintain that cadence throughout the test. After a 2-minute unloaded warm-up, resistance increased by 25 W each minute until the athlete could not continue. Blood pressure was manually measured every 2 minutes during the GXT, and ratings of perceived exertion (RPE) were obtained each minute using Borg's 6-20 scale. Athletes were considered to have achieved a maximal effort if 2 of the following criteria were met: (a) a heart rate within 12 $b \cdot min^{-1}$ of age-predicted maximal heart rate, calculated as $207 - (0.7 \times \text{age in years})$; (b) a respiratory exchange ratio >1.10 or an RPE ≥17 (20). To evaluate aerobic training effects, the same GXT protocol was repeated after the 4-week training period.

*Test Session 2*. During the second test session, individual kettlebell snatch repetitions were determined for athletes in the KB group. A continuous 5-minute kettlebell snatch procedure was used, with the snatch cadence increasing each minute. Athletes used a 12-kg Russian Kettlebell to perform their snatches after a 5-minute warm-up, performing kettlebell swings at their own intensity. During each minute of the test, athletes switched arms, with the dominant arm starting the test. During the first minute, athletes performed 10 snatches or 1 snatch every 6.0 seconds. Snatch cadence increased each successive minute. During the second, third, and fourth minute, athletes performed 14, 18, and 22 snatches, respectively. This corresponded to a snatch cadence of 1 snatch every 4.2, 3.3, and 2.7 seconds, respectively. The test administrator cued athletes by calling "swing" in time with the set cadence. During the fifth minute, athletes performed as many kettlebell snatches as possible, with this number divided by 4. The resulting number represented the kettlebell repetitions performed during each 15-second work interval of the kettlebell training intervention. A Gymboss interval timer (Gymboss; St. Clair, Montana) was used to maintain work and rest intervals (15 seconds each). The number of kettlebell snatches performed during each work interval ranged between 7 and 9 repetitions; 6 athletes performed 9 snatches, 2 performed 8 snatches, and 1 performed 7 snatches during each 15-second work interval.

*Training*. After completing all pretesting, athletes continued their off-season strength and conditioning program under the supervision of the RKC/CSCS. At the time of the study, athletes had already completed 4 weeks of the hypertrophy phase of their periodized strength program. Much of the program was focused on the hips and legs, with standard linear periodization progressions for traditional resistance training. All volumes and load assignments fell under hypertrophy-specific adaptations. Each resistance session lasted approximately 1 hour. After each resistance session, the soccer team finished each training session with aerobic/anaerobic cardiovascular training. The training week consisted of 4 days of on-the-field work. Mondays were heavy aerobic days that repeated each week. Tuesdays consisted of a mix of aerobic and anaerobic soccer-specific skill drills. Thursdays were a speed day involving very high anaerobic sprint bouts. Fridays were programmed for game play. To keep their soccer skills refined, athletes were divided into 2 teams for scrimmages. Independent of the KB and CWT interventions, training was rigorous, and players were intentionally placed under significant amounts of fatiguing work.

Both the KB and CWT groups followed the same resistance training routine. The 20-minute KB or CWT protocols were performed between strength training and on-the-field training sessions. The KB group performed the kettlebell snatch protocol, whereas the CWT group performed a circuit workout consisting of multiple free-weight and body-weight exercises. Athletes performed the KB or CWT intervention on Mondays, Tuesdays, and Thursdays in weeks 1, 2, and 4. In week 3, the intervention sessions were on Tuesday, Thursday, and Friday because of a schedule change. Athletes in the KB group performed the 15:15 $MVO_2$ kettlebell snatch protocol with 15-second work and rest intervals using a 12-kg kettlebell. For every 15-second work interval, athletes performed their individual snatch cadences that were calculated at test session 2. They were instructed to perform their snatches as fast as possible. The first work interval was performed with the dominant arm, with arms switched for each subsequent 15-second work interval. This was repeated for 20 minutes, although the total work time was 10 minutes.

The CWT group performed different free-weight and dynamic body-weight exercises as part of a circuit during the 20-minute training sessions. The circuit incorporated multiple muscle groups and was developed by the RKC/CSCS. Athletes completed 5 exercises in succession (1 set), and a total of 5 sets, for a work time of 10 minutes. The 5 exercises included 20 ball squats, 20 sit ups, 10 windmills, 10 jump squats, and a 400-m sprint/run. Each set of 5 exercises was completed in 2 minutes, with a 2-minute rest period between sets. Athletes performed ball squats and jump squats by deep squatting to a medicine ball, using body weight only. During jump squats, athletes jumped explosively out of the deep squat

**Table 1.** Demographics and aerobic capacity.*

| | KB group ($n$ = 9) | CWT group ($n$ = 8) |
|---|---|---|
| Age (yrs) | 19.9 (1.1) | 19.5 (1.1) |
| Height (cm) | 170.1 (4.3)† | 161.7 (5.5) |
| Weight, before (kg) | 68.1 (9.4)† | 59.9 (3.4) |
| Weight, after (kg) | 67.2 (8.9)† | 59.9 (3.4) |
| $\dot{V}O_2max$, pre ($ml \cdot kg^{-1} \cdot min^{-1}$) | 36.2 (3.2) | 37.8 (3.1) |
| $\dot{V}O_2max$, post ($ml \cdot kg^{-1} \cdot min^{-1}$) | 38.5 (3.9)‡ | 38.1 (2.5) |
| Change, pre to post ($ml \cdot kg^{-1} \cdot min^{-1}$) | 2.3 (2.0) | 0.3 (2.9) |

*Values are presented as mean (*SD*).
†$p \leq 0.05$ compared with CWT group.
‡$p = 0.008$ compared with pre-$\dot{V}O_2max$.

position. Windmills were performed by side bending while stabilizing a 12-kg kettlebell overhead. Because this exercise did not involve ballistic movements with the kettlebell, it was not classified as kettlebell training in this study. Both groups were supervised and encouraged to work as hard as possible. All athletes completed at least 75% of the training sessions.

#### Statistical Analyses

Descriptive statistics (mean and *SD*) were calculated for age, height, weight, and pre-$\dot{V}O_2$max and post-$\dot{V}O_2$max values. A two-way repeated-measures analysis of variance (ANOVA) was planned to evaluate differences in $\dot{V}O_2$max between the KB and CWT groups over time, with the alpha level set at $p \leq 0.05$. However, the normality assumption for the 2-way repeated-measures ANOVA was not met; thus, *t*-tests were used to examine differences in the pre-$\dot{V}O_2$max and post-$\dot{V}O_2$max values for the KB and CWT groups. With alpha set at $p \leq 0.05$, statistical power was 0.84 and 0.05 for the KB and CWT groups, respectively.

### Results

Demographic and $\dot{V}O_2$max data are reported in Table 1. In general, athletes in the KB group were taller and heavier than those in the CWT group. There was no significant difference in aerobic capacity between the KB and CWT groups before the intervention ($t_{[15]} = 1.027$, $p = 0.321$) or after the intervention ($t_{[15]} = -0.299$, $p = 0.769$). The 4-week intervention did not significantly increase aerobic capacity in the CWT group ($t_{[7]} = -0.253$, $p = 0.808$); however, there was a significant increase in the KB group ($t_{[8]} = -3.482$, $p = 0.008$). The average increase was 2.3 $ml \cdot kg^{-1} \cdot min^{-1}$, or approximately a 6% gain. Additionally, the change in aerobic capacity was compared between the KB and CWT groups. The data did not meet the normality assumption for a *t*-test; thus, the difference in median values between the groups was examined using a Mann-Whitney rank-sum test. The median change for the KB and CWT groups was 2.1 and 0.15 $ml \cdot kg^{-1} \cdot min^{-1}$, respectively (Mann-Whitney *U* statistic = 58.0, $p = 0.038$); the increase in aerobic capacity in the KB group was significantly greater than the increase in the CWT group. Thus, kettlebells can be used as a training modality within a high-intensity interval training program to improve aerobic capacity in female collegiate soccer players.

### Discussion

This is one of the first studies to investigate the effects of kettlebell training on aerobic capacity. Previous studies have measured HR and $\dot{V}O_2$ responses during a single kettlebell exercise session, with results indicating that the intensity is sufficient to improve aerobic capacity (4,17). However, Jay et al. (12) found no gain in aerobic capacity after an 8-week progressive kettlebell program. Participants in the study by Jay et al. were relatively inactive and had no previous kettlebell experience. The kettlebell exercises included swings and deadlifts, which are appropriate exercises for beginners. In contrast, participants in this study were intercollegiate athletes who regularly trained with kettlebells, and the training protocol used high-intensity kettlebell snatches. Although this study used a 4-week training program compared with the 8-week program used by Jay et al. (12), the exercise intensity was likely much greater. The 15:15 $MVO_2$ protocol is a high-intensity workout with 15-second work and rest intervals. Athletes in this study performed this protocol for 20 minutes (10 minutes exercise and 10 minutes rest), 3 days a week. In contrast, Jay et al. (12) used a progressive kettlebell program with 3 sets of 10 repetitions, and a 30- to 60-second rest between sets. Additionally, Jay et al. used a submaximal test to estimate aerobic capacity, whereas this study measured oxygen consumption during a maximal GXT. Results from this study are consistent with research showing that high-exercise intensities elicit improvements in $\dot{V}O_2$max (6,9). Additionally, Helgerud et al. (8) found that improving $\dot{V}O_2$max in soccer players enhanced their on-field performance by increasing total distance covered, number of sprints, and number of involvements with the ball.

Athletes in the CWT group served as an exercising control group. The CWT was chosen because of its potential to enhance aerobic capacity (15). To equate training time, participants in the CWT group performed a circuit workout consisting of sprints, free-weight, and body-weight exercises for the same exercise duration. In contrast to the 0.3 $ml \cdot kg^{-1} \cdot min^{-1}$ increase in $\dot{V}O_2$max in the CWT group, the KB group gained 2.3 $ml \cdot kg^{-1} \cdot min^{-1}$, or a 6.4% increase in maximal aerobic capacity. When expressed relative to body weight, gains in $\dot{V}O_2$max may result from an increase in muscle oxidative capacity or a loss of body weight. There was no change in body weight for the CWT group over the 4-week intervention; however, the KB group lost an average of 0.9 kg. The average gain in absolute $\dot{V}O_2$max for the KB group was 0.115 $L \cdot min^{-1}$, which represents a 4.7% increase. Thus, the increase in maximal aerobic capacity in the KB group was primarily because of an increase in muscle oxidative capacity, rather than a loss of body weight during the 4-week intervention. The results support the hypothesis that the KB intervention would result in a significant gain in aerobic capacity. Training with kettlebells is becoming increasingly popular; understanding the acute responses and long-term physiological adaptations to this type of training is crucial. Specifically, additional research is needed to evaluate the effects of kettlebell training on aerobic and anaerobic metabolism, strength and power development, and sport performance. The 12-kg kettlebells used in this study were approximately 18% of the average body mass of athletes in the KB training group. To stress the aerobic system, Fung and Shore (5) recommended using a kettlebell weight ≤13% of body mass. Metabolic data were not collected during the kettlebell training workouts; however, the 15-second work and rest intervals required short bursts of high-intensity exercise. This type of exercise activates anaerobic energy systems; however, continuing the workout for

20 minutes resulted in an aerobic training adaptation evidenced by the increase in $\dot{V}O_2max$.

Because this study used the kettlebell snatch, a dynamic and advanced kettlebell exercise, these findings should only be generalized to individuals who are trained and have experience using kettlebells. Additionally, to reduce the risk of injury, athletes were not randomly assigned to the KB and CWT groups; those who exhibited proper technique for the kettlebell snatch were assigned to the KB group. The CWT group performed a CWT program for the same duration as the KB group. In contrast to the KB group, the CWT group did not show a significant gain in aerobic capacity. This could be due to a difference in exercise intensity and total work, as both of these variables were not directly calculated or compared. Because the KB and CWT interventions were included in the off-season strength and conditioning program, controlling athletes' total work and exercise intensity was not possible. Athletes performed a resistance session for approximately 1 hour, then the 20-minute KB or CWT intervention (10 minutes of exercise and 10 minutes of rest), followed by aerobic/anaerobic cardiovascular training. The only difference in the training program between groups was the KB or CWT intervention. Thus, the gain in aerobic capacity in the KB group, with no change seen in the CWT group, can be attributed to the relatively brief KB intervention (10 minutes of exercise, 3 days a week). Although the KB group increased aerobic capacity, the training duration was only 4 weeks. A longer training program may result in greater aerobic adaptations.

## Practical Applications

Kettlebells are a unique and practical tool for training and conditioning. Athletes who use a high-intensity intermittent training program, such as the 15:15 $MVO_2$ kettlebell protocol, may increase aerobic capacity in a short amount of time. This protocol may also be used during injury rehabilitation. Athletes who have sustained a lower extremity injury that warrants little to no impact can perform this protocol as an alternative to maintain aerobic conditioning. The kettlebell snatch is a low-impact dynamic exercise that provides sufficient resistance for muscle strengthening, in addition to enhancing aerobic capacity.

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