THE EFFECT OF KETTLEBELL TRAINING ON BODY COMPOSITION, FLEXIBILITY, BALANCE, AND CORE STRENGTH

A Manuscript Style Thesis Submitted in Partial Fulfillment of the Requirements for the Master of Science in Clinical Exercise Physiology

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THE EFFECT OF KETTLEBELL TRAINING ON BODY COMPOSITION, FLEXIBILITY, BALANCE, AND CORE STRENGTH

By Dustin A. Erbes

We recommend acceptance of this thesis in partial fulfillment of the candidate's requirements for the degree of Master of Science in Clinical Exercise Physiology.

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ABSTRACT

Erbes, D.A. The effect of kettlebell training on body composition, flexibility, balance, and core strength. MS in Clinical Exercise Physiology, December 2012, 43 pp. (J. Porcari)

This study was designed to evaluate the effect of kettlebell training on body composition, flexibility, and balance. Seventeen subjects (9 male, 8 female) completed a kettlebell training protocol which was held two times per week for 8 weeks. Eleven volunteers with similar characteristics served as a control group. Pre and post-testing evaluation included body composition measurements, low back, hamstring, and shoulder flexibility, static and dynamic balance, and core strength tests. No significant differences were seen in body composition (weight, sum of skinfolds, and % body fat), static balance, flexibility (shoulder raise, trunk hyperextension, and sit and reach), or dynamic balance in the anterior direction. Core strength, as measured by the plank test, increased by 70% (45 sec). Also, dynamic balance showed a significant improvement in the posterolateral direction of 7.20 cm (10.7% increase) and there was a similar improvement (p < .05) of 8.6 cm (13.7% increase) seen in the posteromedial direction. Results indicate that kettlebell training can improve dynamic balance as well as core strength and endurance. Incorporating kettlebell training into a workout routine may provide additional benefits not typically seen with traditional training.
ACKNOWLEDGEMENTS

I would first like to extend a thank you to the University of Wisconsin – La Crosse Recreational Eagle Center for allowing us to instruct the kettlebell classes at their facility. Without the generosity and aid from Mo McAlpine and all the staff, the training study would not have gone as smoothly as it did.

I would also like to give thanks to Ray Martinez and Derek Toshner for all their assistance and knowledge about kettlebells. Their experiences with kettlebells were a great help in not only developing workout protocols, but how to optimize and safely progress through each week. The techniques and information Ray brought to the classes he taught were a great help. Also, the willingness of Derek and TNT Fitness to allow us to borrow kettlebells from his workout facility was an immense help. This enabled us to help get the study jump started and set up with the equipment needed to successfully construct workouts. The knowledge and passion that these two men portrayed about kettlebells will be something I will take on to my future endeavors.

I would like to say thank you for all of the participants that were willing to be involved in the study. It is not easy to be as committed and as flexible with their schedules as they were and I commend them for their devotion. It was great getting to know all of you and hope that the kettlebell skills you attained can be beneficial to you in the future.

I would also like to extend a sincere thank you to Giancarlo Condello and my thesis advisor Dr. John Porcari. Giancarlo, your commitment to this study was second to none. Your help and knowledge with testing protocols and data collection was a great help. It was a pleasure to work and get to know you. Dr. Porcari, your help and expertise allowed me to realize what a training study is all about. Your supervision allowed me to successfully conduct and write this study.
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INTRODUCTION

The kettlebell has been used for nearly three centuries, first being mentioned in a Russian dictionary in 1704. Until recent years, the kettlebell had been largely used by Russian military, police, and athletes to enhance physical fitness. Now, however, the kettlebell has emerged as one of the hottest fitness trends to hit the U.S. in recent years. A kettlebell is a cannon ball shaped weight with a U-shaped handle. Because of its shape, a person is able to integrate curvilinear movements, centrifugal force, and momentum into a type of circuit weight training type of workout (Fable, 2010). The kettlebell allows a person to incorporate multiple resistance lifts into a workout in a series of dynamic lifting actions.

There have only been a small number of research studies done on the acute effects of a kettlebell workout. Schnettler et al. (2010) studied the energy cost and relative intensity of a 20-minute kettlebell workout. They found that subjects averaged 93% of maximum heart rate (HR max) and 78% of maximal oxygen consumption (VO₂ max), respectively, during a kettlebell snatch workout. A study by Farrar et al. (2010) found results similar to those of Schnettler et al. (2010). They found that the “Man Maker” kettlebell workout elicited an average heart rate (HR) of 165 beats/min (87% of HRmax) and oxygen consumption (VO₂) of 34.3 ml/kg/min (65% of VO₂ max). Thus, the metabolic overload provided by kettlebell training should result in positive changes in body composition and aerobic capacity (ACSM, 2010).
Many of the kettlebell exercises involve multi-joint movements, where the lifts originate from the floor and the weight is raised above the head. Therefore it is reasonable to assume that kettlebell exercise routines could potentially increase flexibility and balance. For instance, a study by Kiebele and Behm (2009) looked at lower body resistance training workouts. The study found a 12.4% reduction in time to go across a balance beam and found a 44% reduction in wobble board contacts. Wilmore et al. (1978) studied the effects of resistance weight training on flexibility. Flexibility was measured with the sit-and-reach and back arch tests in inches. Improvements seen on the aforementioned tests were +0.5 and +0.4 for men and +1.3 and +0.7 for women, respectively.

The purpose of this study was to determine the impact of a 9-week kettlebell training program on body composition, flexibility, balance, and core strength. This study was part of a larger study that determined changes in aerobic capacity and strength due to a kettlebell exercise routine.
METHODS

Subjects

Eighteen volunteers (9 male, 9 female) were recruited from the University of Wisconsin-La Crosse campus to participate in this study. Twelve volunteers (6 male, 6 female) with similar characteristics were recruited for a control group. Due to the physical demand of the kettlebell workout, participants were required to have some prior experience with resistance weight training and to be at least be recreationally active.

Procedures

Subjects were required to complete the Physical Activity Readiness Questionnaire developed by ACSM and the American Heart Association (AHA) as well as to provide written informed consent before beginning the study. The protocol was approved by the University of Wisconsin-La Crosse Institutional Review Board for the Protection of Human Subjects. Subjects underwent a series of tests before and after the kettlebell training program. This portion of the study assessed body composition, flexibility, balance, and core strength.

Body composition was assessed using three skinfold sites. Skinfold thickness at each site was measured using a Lange skinfold caliper (Cambridge Scientific Industries, Inc., Maryland). Sites measured on the male subjects were the chest, abdomen, and thigh; for women the sites were the triceps, suprailium, and thigh. All measurements were made on the right side of the subject’s body. Three measurements were made and averaged for use in the data analysis. Body density was predicted using separate male
(Pollock & Jackson, 1978) and female (Pollock, Jackson, & Ward, 1980) generalized regression equations. Conversion of body density to percent body fat was calculated using to the Siri equation (Siri, 1961).

Flexibility was measured by using a sit-and-reach test, trunk hyperextension test, and shoulder raise test. For the sit-and-reach test, subjects removed their shoes and sat on the floor with legs fully extended and feet flat against the sit-and-reach box. The subject slowly reached forward as far as possible with both hands. Instructions were given to not lead with one hand or jerk for additional distance. The investigator placed his hands on the subject’s knees, not pressing down, but to ensure the legs stayed straight during the reach (ACSM, 2010). The test was performed three times and the highest recorded number was used in the data analysis.

The trunk hyperextension was conducted in order to evaluate trunk and neck flexibility. Subjects lied prone on the floor with their hands clasped together and placed on the lower lumbar region of the back. The subject then raised their upper body as high as possible off the floor, flexing at the lumbar region, while keeping the dorsal surface of their feet and their hips in contact with the floor. The investigator then used a meter stick to measure the height distance from the floor to the tip of the nose. Subjects repeated the test three times and the highest score was used in the data analysis.

The shoulder raise test was used to evaluate shoulder flexibility. The subject started in the prone position with their arms extended straight out above their head. The subjects were then asked to grab a broom stick with their hands shoulder width apart and raise the stick as high as possible while keeping their chin in contact with the floor and wrists in the neutral position. A point of emphasis was made to keep the wrists in a
neutral position. A restart to the attempt was given if either of the instructions were not followed correctly. The distance the broom stick was lifted from floor was measured with a meter stick. The measurement was taken from the floor to the bottom side of the stick at the highest point. Subjects attempted the test three times and the highest score was used for data analysis (Heyward, 1984).

Balance was measured using static and dynamic balance tests. Static balance was assessed with the static one-legged balance test. Subjects' started by first placing their arms crossed across their chest. They then lifted their non-dominant leg up to a 90° angle at hip and also at the knee. When in the proper position, they closed their eyes. The stopwatch was started when the subject closed their eyes. The stopwatch was stopped if the subject’s non-dominant leg touched the ground, the dominant foot suddenly changed positions, or if the eyes opened. The best of two trials was recorded for data analysis.

Dynamic balance was evaluated using the Y balance test (Plisky et al., 2009). The Y balance test assesses the subjects maximal reach distances in the anterior, posteromedial, and posterolateral directions. The structure of the Y balance testing device consisted of three push boxes that slide on tubing with predetermined markings incremented by 0.5 cm. The push box slides on the measured tubing as the subject pushed it with their right foot. While standing on their left foot, the subject reached and pushed the slide box in a controlled fashion as far as possible in the anterior direction with their right foot (Figure 1). The subject repeated the test in the posteromedial (Figure 2) and posterolateral (Figure 3) directions. Subjects were only tested while standing on their left foot and shoes removed. If the subjects touched the push foot to the ground,
rested it on the tubing, or lost balance, the try did not count. The greatest distance in each
direction was used in the data analysis.

Core strength was measured by performing the plank test. Subjects were
instructed to have their elbows, forearms, and feet in contact with the floor while in the
prone plank position. Elbows were to be directly below shoulders throughout entire test.
When the subject was in the correct position, the timer was started. Also, a broomstick
was placed on the subject's back for evaluation of form throughout the test. If the lumbar
region of the back failed to keep contact with the broomstick, the test was stopped. The
timer was also stopped if plank form was compromised or subject stopped due to fatigue.
One maximal trial was recorded for evaluation.

Training

Subjects that were involved in the training portion of the study took part in
kettlebell classes twice a week for a nine-week period. The focus of the first week was to
train the subjects in proper form and technique. This first week was not considered part
of the training period. Following the first week, subjects were assessed for body
composition, flexibility, and balance as described previously. The next 8 weeks
consisted of 45-60 minute classes. The classes included an active warm-up of light
stretching and calisthenics for approximately 5 minutes. The warm-up was followed by a
30-45 minute class involving multiple variations of kettlebell exercises. This was
followed by a 10-minute cool-down period. Subjects were encouraged to use a
comfortable weight at the beginning of the study and progress to heavier weights as they
felt more comfortable throughout the study. Kettlebell classes were instructed by two
instructors who are certified through the National Exercise Trainers Association (NETA).
After completion of the 8-week training period, subject’s body composition, flexibility, balance, and core strength were reevaluated using identical procedures as the pre-tests.
STATISTICAL METHODS

Independent t-tests were performed to identify any pre-testing differences between the experimental and control groups for each variable. A 3-way (pre-post x group x gender) ANOVA with repeated-measures was used to determine differences consequent to the training period for each variable. When there was a significant F ratio, Tukey’s post-hoc tests were used to make pairwise comparisons. Significance was set at an α level of 0.05 to achieve statistical significance. All analyses were conducted using the Statistical Package for the Social Sciences (SPSS, Version 19; SPSS Inc., Chicago, IL.)
RESULTS

Initially there were 18 subjects in the experimental group and 12 subjects in the control group. One female from the experimental group did not complete the study due to time commitments and one male in the control group could not complete the post-testing due to injury. Descriptive characteristics of subjects who completed the study are presented in Table 1. The experimental and control subjects were similar in age, height, and weight. All subjects in the experimental group completed 16 exercise sessions during the 8-week training period. If a session was missed during the week, make-up sessions were held on weekends.
Table 1. Descriptive characteristics of the subjects.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Experimental</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male (n)</td>
<td>9</td>
<td>5</td>
</tr>
<tr>
<td>Age (years)</td>
<td>22.1 ± 2.80</td>
<td>22.2 ± 2.28</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>177.8 ± 4.90</td>
<td>178.8 ± 4.52</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>77.7 ± 10.86</td>
<td>79.9 ± 15.76</td>
</tr>
<tr>
<td>Female (n)</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>Age (years)</td>
<td>21.5 ± 3.93</td>
<td>21.2 ± 1.72</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>164.3 ± 5.72</td>
<td>164.8 ± 2.62</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>64.5 ± 12.56</td>
<td>58.7 ± 4.17</td>
</tr>
</tbody>
</table>

Changes in study variables from pre to post-testing are presented in Table 2. There were no significant differences in the responses of males and females over the course of the study, thus only group data is presented. There were no significant pretesting differences between the control and experimental groups for any variable. There were no significant changes in body composition (body weight, sum of skinfolds, and % bodyfat) for either group over the course of the study. There were also no significant differences in sit-and-reach, shoulder raise, or trunk hyperextension in either group over the course of the study.

Static balance was measured with a one-leg balance test and there were no significant changes from pre to post-testing in either group. Dynamic balance was measured in the anterior, posterolateral, and posteromedial planes. There was no significant change in either group in the anterior direction. However, in the posterolateral direction, the experimental group had a significant improvement from pre to post-testing.
compared to the control group. In the posteromedial direction, a similar trend was seen. However, the improvement for the experimental group was not significantly greater than the control group (p=.071). The experimental group had a significant improvement in core strength, as measured by the plank test, compared to the control group.

Table 2. Changes in body composition, flexibility, balance, and core strength over the course of the 8-week study.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Pretest</th>
<th>Post-test</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Weight (kg)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experimental</td>
<td>71.5 ± 13.18</td>
<td>71.6 ± 13.59</td>
<td>0.10</td>
</tr>
<tr>
<td>Control</td>
<td>68.3 ± 15.18</td>
<td>68.8 ± 15.20</td>
<td>0.50</td>
</tr>
<tr>
<td><strong>Sum of Skinfolds (mm)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experimental</td>
<td>47.4 ± 15.63</td>
<td>47.3 ± 14.92</td>
<td>-0.10</td>
</tr>
<tr>
<td>Control</td>
<td>45.7 ± 15.15</td>
<td>46.9 ± 16.51</td>
<td>1.20</td>
</tr>
<tr>
<td><strong>Body Fat (%)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experimental</td>
<td>16.3 ± 6.62</td>
<td>16.3 ± 6.25</td>
<td>0.00</td>
</tr>
<tr>
<td>Control</td>
<td>18.5 ± 4.77</td>
<td>18.8 ± 5.10</td>
<td>0.30</td>
</tr>
<tr>
<td><strong>Sit-and-Reach (cm)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experimental</td>
<td>32.9 ± 7.93</td>
<td>32.9 ± 7.98</td>
<td>0.00</td>
</tr>
<tr>
<td>Control</td>
<td>35.3 ± 6.50</td>
<td>36.0 ± 6.73</td>
<td>0.70</td>
</tr>
<tr>
<td><strong>Trunk Hyperextension (cm)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experimental</td>
<td>42.9 ± 5.39</td>
<td>43.4 ± 5.16</td>
<td>0.50</td>
</tr>
<tr>
<td>Control</td>
<td>39.6 ± 5.00</td>
<td>40.5 ± 4.13</td>
<td>0.90</td>
</tr>
<tr>
<td><strong>Shoulder Raise (cm)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experimental</td>
<td>29.6 ± 15.68</td>
<td>27.3 ± 14.8</td>
<td>-2.30</td>
</tr>
<tr>
<td>Control</td>
<td>23.2 ± 11.60</td>
<td>22.7 ± 9.47</td>
<td>-0.50</td>
</tr>
<tr>
<td><strong>Static Single Leg Balance (sec)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experimental</td>
<td>17.4 ± 10.02</td>
<td>16.7 ± 9.42</td>
<td>-0.70</td>
</tr>
<tr>
<td>Control</td>
<td>14.0 ± 15.76</td>
<td>15.2 ± 11.59</td>
<td>1.20</td>
</tr>
<tr>
<td><strong>Dynamic Balance Anterior (cm)</strong></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Experimental</td>
<td>Control</td>
<td>p</td>
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<tr>
<td>--------------------------</td>
<td>--------------</td>
<td>---------------</td>
<td>-----</td>
</tr>
<tr>
<td></td>
<td>59.0 ± 5.51</td>
<td>60.3 ± 6.28</td>
<td>1.40</td>
</tr>
<tr>
<td></td>
<td>61.5 ± 6.80</td>
<td>60.4 ± 7.41</td>
<td>-1.20</td>
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### Dynamic Balance

<table>
<thead>
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<th></th>
<th>Experimental</th>
<th>Control</th>
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<tbody>
<tr>
<td><strong>Posteromedial (cm)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>64.4 ± 7.72</td>
<td>73.0 ± 7.26</td>
<td>8.60*</td>
</tr>
<tr>
<td></td>
<td>71.1 ± 8.30</td>
<td>74.9 ± 8.09</td>
<td>3.80</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Experimental</th>
<th>Control</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Posterolateral (cm)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>67.2 ± 6.33</td>
<td>74.4 ± 7.59</td>
<td>7.20*#</td>
</tr>
<tr>
<td></td>
<td>71.8 ± 8.85</td>
<td>74.6 ± 9.80</td>
<td>2.80</td>
</tr>
</tbody>
</table>

### Plank (min:sec)

<table>
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<tr>
<th></th>
<th>Experimental</th>
<th>Control</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1:05 ± 0:30</td>
<td>1:12 ± 0:31</td>
<td>0:45*#</td>
</tr>
<tr>
<td></td>
<td>1:01 ± 0:30</td>
<td></td>
<td>0:11</td>
</tr>
</tbody>
</table>

*Significant change from pre to post-testing (p ≤ 0.05)

#Change significantly different than control group (p ≤ 0.05)
DISCUSSION

The purpose of this study was to determine the impact of 8-weeks of kettlebell training on body composition, flexibility, balance, and core strength. One of the most significant findings of the study was a 70% increase in core strength in the experimental group. While the kettlebell training program was not designed specifically to improve core strength, a majority of the exercises done with the kettlebell involve the core muscles to be contracted throughout the entire movement. This core muscle activation is called "kime." This kime concept was examined by McGill & Marshall (2012) and is the term used to describe the abdominal pulse at the top of the kettlebell swing. A kettlebell swing with kime is performed the same way as the kettlebell swing, with addition of a "pulse-like" contraction of the abdominals when the kettlebell reaches chest height. In their studies, EMG was used to evaluate muscle activation during a number of kettlebell exercises. During one arm swings, the rectus abdominis and external obliques were contracting at 20% of MVIC and the internal obliques were contracting at 30% of MVIC. When the kime technique was added to the swing, EMG activity increased to 101% and 140% in the right and left external obliques, respectively. Even though this specific kime technique was not focused on by trainers in the current study, a strong emphasis was placed on contracting the core and leg muscles at the top of the kettlebell swings.

It has been suggested that increased core strength may be helpful in reducing the risk of low back injury and low back pain. Jay et al. (2011) studied the effectiveness of kettlebell training to improve musculoskeletal health. Forty participants took part in a full-body kettlebell training program that was held 3 times per week for 8 weeks in which
trunk extensor muscle strength increased by 19.6% as a result of training. Low back and neck/shoulder pain was evaluated before and after training using a 0-10 scale. It was found that when compared to the control group, pain intensity in the neck/shoulders decreased 2.1 points and low back pain decreased 1.4 points in the training group. It appears that kettlebell training can be an appropriate fitness tool, when used correctly, to increase core strength and endurance, as well as reduce the occurrence of musculoskeletal pain symptoms.

The current study found a 7.20 cm (10.7%) increase in dynamic balance in the posterolateral direction in the training group, which was significantly greater than the control group. There was a similar increase of 8.6 cm (13.7%) in the posteromedial direction. However, the increase did not reach statistical significance compared to the control group. Because there is limited research on kettlebell training, no other study could be found which investigated dynamic balance consequent to kettlebell training. In fact, there have been very few studies that have examined changes in dynamic balance after resistance exercise. Keibele and Behm (2009) compared the effects of traditional and unstable lower body resistance training workouts on dynamic balance. Training was conducted twice a week for a 7-week period, which was similar in length to the current study. Significant improvements in the time to traverse a balance beam (12.4%) and fewer wobble board contacts (44.8%) occurred after training. The authors hypothesized that with the instability exercises, the body had to adapt and continually correct for the center of gravity sway, which resulted in the increase in balance. This concept may help to explain the increase in dynamic balance in the current study. One of the primary exercises used was the kettlebell swing. The kettlebell swing is performed using a longer
lever arm than traditional dumbbell exercises. In between the start and finish phase at the
top of the kettlebell swing, there is a great deal of force and balance needed to keep the
body upright and stable. This could be a factor as to why an increase in dynamic balance
was observed. Also, lunges were performed in the anterior, lateral, and posterior
direction done while holding the kettlebell overhead and in the racked position. This may
have also contributed to the increase in dynamic balance.

Weight, skinfold thickness, and body composition did not show improvement
over the course of the study. Male and female subjects averaged 11.2% and 22.1% body fat, respectively, at the beginning of the study. Men were in the good-excellent range and women scored in the fair category according to published norms for the 20-29 year olds (ACSM, 2010). Thus, with the training group participants initially having “normal” body fat values, room for improvement was minimal. Training was also only held twice a week for 8 weeks and subject’s diet was not controlled. A longer training period with more frequent training sessions may have had a greater impact on results.

Static single leg balance did not improve over the course of the study. One factor
that may have contributed to this was the fact that the test did not appear to be very
reliable. The test-retest reliability calculated from the results of the control group was
only r=0.54.

Sit-and-reach, trunk hyperextension, and shoulder flexibility also did not change
over the course of the study. Because subjects in the study were all college-aged, active
individuals who were already fairly flexible, this result was not totally unexpected. For
example, for sit-and-reach flexibility, pretesting values were already in the fair to good
category according to ACSM norms (2010), thus room for improvement was limited.
Additionally, many of the exercises that were utilized during the current study did not emphasize direct hamstring or lumbar flexibility. Even though many of the kettlebell exercises started from the floor, they were initiated with bent knees as opposed to elongating the hamstrings. Training also did not emphasize back or shoulder hyperextension beyond a normal range of motion.

There were several limitations involving the conduct of the study which could have impacted results. One limitation was that due to space availability, training classes could only be held twice a week for 8 weeks. More frequent and longer duration may have resulted in more significant results. Another limitation was that minor injuries and muscle soreness played a role in how hard the subjects exerted themselves during all of the workouts. A final limitation was that all of the subjects were new to kettlebell training. As a result, a great deal of attention was spent on safety and correct form for each exercise. Thus, advancement to more technical kettlebell exercises had to be incorporated more slowly. This may have played a role in how hard the subjects exerted themselves over the course of the study and impacted how much they improved.
CONCLUSION

In conclusion, the current study found significant increases in dynamic balance as well as core strength after the 8-week training study. However, the training protocol did not yield significant improvements in body composition, flexibility, or static balance. As kettlebell training becomes increasingly popular in the fitness industry, additional studies are needed to determine further benefits of using kettlebells.
REFERENCES


APPENDIX A

INFORMED CONSENT
INFORMED CONSENT

TRAINING BENEFITS CONSEQUENT TO 8 WEEKS OF KETTLEBELL EXERCISE

I, ________________________________, volunteer to participate in a research study being conducted by the University of Wisconsin-La Crosse.

Purpose and Procedures

- The purpose of this study is to determine the fitness benefits resulting from 8 weeks of kettlebell training.
- Research assistants will be conducting the research under the direction of Dr. John P. Porcari, a Professor in the Department of Exercise and Sport Science.
- My participation in this study will involve the completion of a series of tests before and after the kettlebell training period. These tests will include:
  - A maximal aerobic capacity (VO₂max) test. For this test I will be asked to lift an individually prescribed kettlebell at an increasing rate until I can no longer continue. The test will start out at a slow pace and progressively increase each minute until I can no longer continue. During the test I will wear a chest strap to measure my heart rate and a face mask to analyze by expired air.
  - Maximal strength of my back and shoulders will be assessed using three different exercises; one will involve lifting as much weight as I can off of the ground, one will involve lifting as much weight as I can to shoulder height, and one lift will involve lifting as much weight as I can overhead with one hand.
  - My flexibility will be assessed with a sit-and-reach test where I will reach forward as far as possible while in a sitting position, and a back arch flexibility test where I will arch up as high as possible while lying face-down on the floor.
  - My balance will be assessed by balancing on one foot, lifting opposite foot off ground at 90°, and closing eyes. I will stay upright and balanced on one foot as long as possible.
  - My body composition will be assessed using a series of skinfold measurements.
- For training, I will be asked to participate in an 8-week kettlebell training program. The program will be held at the UW-La Crosse Eagle Recreational Center and be led by certified kettlebell instructors. Each class will be approximately 60 minutes in length, including a warm-up and cool-down period.
• Total time commitment for this study will be approximately 24 hours, including all of the testing and training sessions.

Potential Risks

• I may experience muscle fatigue and muscle soreness as a result of completing the exercise tests and workouts used in the current study. Additionally, shortness of breath, irregularities in heart rhythm, heart attack, stroke, and even death are possibilities of vigorous exercise. However, the risk of serious or life-threatening complications is very low (<1/10,000 tests) in apparently healthy adults.

• All testing and training sessions will be stopped immediately if there are any complications.

• Individuals trained in CPR and Advanced Cardiac Life Support (ACLS) will be available during all testing sessions. Additionally, an Automatic External Defibrillator (AED) is available in both the testing and training sites.

Benefits

• As a participant in this study, I will learn by base level of aerobic fitness, strength, flexibility, balance, and body composition.

• As a result of the training sessions I will be participating in, it is reasonable to expect an improvement if at least some of the above measurements.

Rights and Confidentiality

• My participation in this study is entirely voluntary.

• I may choose to discontinue my involvement in the study at any time, for any reason, without penalty.

• The results of this study have the potential of being published or presented at scientific meetings, but my personal information will be kept confidential and only group data will be presented.
I have read the information provided on this consent form. I have been informed of the purpose of this study, the procedures, and expectations of myself and the testers, and of the potential risks and benefits that may be associated with volunteering in this study. I have asked any and all questions that concerned me and received clear answers so as to fully understand all aspects of this study.

If I have any other questions that arise I may feel free to contact John Porcari, the principal investigator, at (608) 785-8684. Questions in regards to the protection of human subjects may be addressed to the University of Wisconsin-La Crosse Institutional Review Board for the Protection of Human Subjects at (608)785-8124.

Subject: ___________________________  Date: ___________________________

Investigator: _________________________  Date: ___________________________
APPENDIX B

PHOTOS OF SUBJECT PERFORMING DYNAMIC BALANCE TESTING
Figure 1. Dynamic balance test in anterior direction
Figure 2. Dynamic balance test in posterolateral direction
Figure 3. Dynamic balance test in posteromedial direction
APPENDIX C

REVIEW OF LITERATURE
REVIEW OF LITERATURE

The purpose of this paper is to review the literature regarding the use of a kettlebell and the effect it has on body composition, flexibility, balance, and core strength. Due to a lack of research on the above mentioned attributes, circuit weight training, resistance training, and similar weight exercise workouts will be discussed.

Background of Kettlebells

The kettlebell dates back to the early 1700s, originating in Russia. It was used in these times as a counterweight in the markets for selling produce (Brumitt et al., 2010). It went from a counterweight, to a Russian farmer’s idea of “fun” by juggling these weights, and eventually into a popular Russian training tool for the Soviet military and police (Fable, 2010; Hedegaard, 2002). It was not until the late 1990s when Pavel Tsatsouline, a former Russian military trainer, introduced kettlebell workouts into the U.S. Tsatsouline developed workouts with the kettlebell (which come in sizes ranging from 9 to 88 lbs) that include lifts, presses, squats, abdominal exercises, and cardiovascular drills. Tsatsouline stated that if the exercises are done correctly, they will work all the major muscle groups (Hedegaard, 2002).

Swinging the kettlebell increases rotational inertia as the body engages other muscles to direct and control the momentum, which in turn mimics real life movements. Some of those involved in the fitness industry believe that many of the same effects could be recreated with a dumbbell, however, unlike a dumbbell, the kettlebell forces the weight outside the performers hand and creates a dynamic imbalance for which the body must compensate (Fable, 2010). Elements such as acceleration, stabilization, and deceleration are experienced when swinging the kettlebell. There are multiple swinging movements that are involved in the kettlebell workouts, but the traditional press and pull...
strength exercises can be performed with the weights as well. Kettlebell exercises involve the whole body by integrating multiple muscle groups at once and using core stabilization (Fable, 2010).

Effects of Circuit Weight Training on Body Composition

Wilmore et al. (1978) measured the energy cost of circuit weight training. A group of 40 subjects (20 men and 20 women) volunteered to perform a 10 station circuit using a 2:1 ratio of work to rest (30 seconds exercise and 15 seconds rest). The results found that energy expenditure was highly correlated to body weight. The average gross energy expenditure for men and women was 539.7 and 367.5 kcal/hr, respectively.

Mayhew and Gross (1974) explained how circuit weight training involves multiple large muscle groups during training. Twenty-seven female subjects (17 in the weight training class and 10 controls) were involved in this study. The weight training group exercised approximately 40 minutes a day, 3 times per week and completed a circuit routine on universal gym equipment. Following the 9-week training period, there was no change to total body weight, but there was a significant increase in lean body weight (+1.4 kg) and loss of fat weight (-1.2 kg). The authors also noted that the loss of fat mass coupled with the increase in lean body mass canceled each other out, thus resulting in no change in body weight.

Effects of Weight Training on Flexibility and Balance

Wilmore (1978b) conducted a similar study to his energy cost experiment, but this time evaluated the physiological alterations consequent to circuit weight training. A
group of subjects consisting of 16 men and 12 women followed a 10 station universal gym circuit training protocol. The circuit involved 3 circuits/day (~22.5 min/day), 3 days/week. The subjects exercised at 40-55% of 1-RM, doing as many repetitions as possible in 30 seconds for each lift, followed by a rest period of 15 seconds. The experimental groups had significant gains in lean body weight, flexed bicep girth, and flexibility. For flexibility, the women improved by 1.1 inches on the sit-and-reach test, which was a 5.1% increase from the pretest. It is worth noting that although the men did not improve in the sit-and-reach test, they did not decrease either. Therefore, weight training does not decrease flexibility, a point that Karpovich had addressed (Karpovich & Sinning, 1971).

Keibele and Behm (2009) compared the benefits of traditional and unstable lower body resistance training workouts. Forty participants were divided into unstable and stable resistance training groups. Unstable training was conducted by subjects standing on BOSU balls to simulate unstable ground. Stable training was conducted in a fashion similar to traditional resistance training. Training was conducted twice a week for a 7-week period. Pre and post testing measurements of static and dynamic balance were conducted. Results showed that there were no differences in strength gains between unstable and stable resistance training groups. However, significant improvements in the time to traverse a balance beam (12.4%) and a fewer number of wobble board contacts (44.8%) occurred. Training effects were also independent of subject gender. One possible explanation for the lack of difference in the stable vs. unstable training is that subjects used lower weights when lifting on the unstable surface. The authors explained that during the instability exercises, the body adapts and corrects for center of gravity
sway. This core and trunk activation may be evident in the exercises conducted for the kettlebell workout because the kettlebell allows for a longer lever arm than traditional dumbbells. This allows a subject to exercise with a lower weight at the same intensity that a higher weight would offer.

The American College of Sports Medicine (ACSM) recently issued new recommendations on the quantity and quality of exercise recommended for apparently healthy adults (2011). The revised basic recommendations for flexibility exercise state that adults should do flexibility exercises at least 2 or 3 days each week to improve range of motion (ROM). Each stretch should be held for 10-30 seconds to the point of tightness or slight discomfort and repeat each stretch should be repeated 2-4 times. It is recommended that flexibility exercises are most effective when the muscle is warm, and it was also stated that static, dynamic, and ballistic stretches are all effective at increasing ROM (ACSM, 2011).

Kettlebell Research

Schnettler (2010) examined the energy cost and relative exercise intensity of a kettlebell workout. The study involved 10 subjects (8 males, 2 females) and was conducted in two parts. The first part of the study compared the results of their treadmill maximal oxygen consumption (VO2max) test to a 5-minute VO2max kettlebell snatch test. Results showed there was a significant difference between the treadmill VO2max and the kettlebell VO2max values (49.7±6.6 vs. 40.3±2.2, respectively). The second part of the study documented the relative exercise intensity of a 20-minute kettlebell snatch workout. It was found that the kettlebell workout met ACSM guidelines for exercise
intensity. Average VO_{2\text{max}} values during the kettlebell snatch workout were between 67 and 91% of VO_{2\text{max}} values. Average heart rate (HR) values during the kettlebell snatch workout were between 86 and 99% of maximal heart rate (HR_{\text{max}}).

Farrar et al, (2010) examined the energy cost and intensity of the 12-minute "Man-Maker" workout. Ten college-aged men completed a GXT for determination of VO_{2\text{max}} and 2-7 days later completed a kettlebell exercise routine consisting of as many two-handed swings possible in 12 minutes using a 16 kg kettlebell. They found that the average %HR_{\text{max}} (89%) during kettlebell exercise was significantly higher than the average %VO_{2\text{max}} (65%). They concluded that continuous kettlebell swings can elicit a metabolic challenge that is of high enough intensity to increase VO_{2\text{max}}, but also stated %HR_{\text{max}} achieved during continuous kettlebell exercise are significantly higher than %VO_{2\text{max}} values.

Jay et al. (2011) studied the effects of kettlebell training on musculoskeletal and cardiovascular health. The study included 40 adults who had musculoskeletal pain symptoms in the neck/shoulders and low back. Participants were randomly assigned to training which consisted of ballistic full-body kettlebell exercise 3 times per week for 8 weeks or to a control group. The main variables evaluated were pain intensity of the neck/shoulders and low back, isometric muscle strength, and aerobic fitness. Compared to the control group, pain intensity of the neck/shoulders decreased 46% and pain intensity of low back decreased 57% in the training group and increased muscle strength of the trunk extensors (19.6% increase) whereas aerobic fitness remained unchanged. This data shows that the kettlebell training can be incorporated into a rehabilitation program and yield positive results.
Brumitt et al. (2010) investigated the use of kettlebells as a rehabilitation instrument for injured athletes. The shape of the kettlebell allows for unique exercise application, which is what a physical therapy sport rehabilitation program desires. The kettlebell’s center of mass creates a long lever arm during the swinging motion. The authors state that when the kettlebell is compared to exercises with a shorter lever arm (dumbbells, ball weights, etc.), the muscles that eccentrically decelerate the swinging motion may be at a greater mechanical disadvantage and thus may require greater force production to complete a repetition. At terminal extension, the kettlebell is returned to the starting position assisted by gravity, controlled by eccentric muscle contractions of the extremity and core musculature, whereas a dumbbell is at a fixed location for the entire movement. They also commented about the small number of cited kettlebell studies, but inferred that there is enormous potential for it in the rehabilitation and fitness world.

McGill and Marshall (2012) studied the kettlebell swing, snatch, and bottoms-up carry and how they relate to back and hip muscle activation, motion, and low back loads. The study attempted to quantify the spinal loading during kettlebell swings and carries. Seven male subjects, as well as a highly accomplished kettlebell master, participated in this study. Electromyography, ground reaction forces, and 3D kinematic data was recorded during the exercises, which were completed using a 16 kg kettlebell. Results found that kettlebell swings create a hip-hinge squat pattern, due to the rapid muscle activation and relaxation cycles. As a result, the low back extensors contracted at 50% of MVC and the gluteal muscles were contracted at 80% MVC. “Kime” is described as an abdominal pulse-like contraction at the top of the kettlebell swing. The addition of “kime” to the kettlebell swing resulted in the largest increase in abdominal activation in
the right external oblique (101% increase) and left external oblique (140% increase).

Also, an interesting loading pattern was associated with the kettlebell swing, in that the posterior shear forces at the level of the 24/25 vertebra are opposite of a traditional lift. The authors state that this may be why credit is given to the kettlebell for restoring and enhancing back health and function. However, few subjects did mention that it irritated back pain further. The authors state that this irritation would have been due to the unfamiliarity of the shear forces on the spine mentioned above.

Summary

In conclusion, it has been stated that there is great potential for use of the kettlebell in the fitness world. Due to there being a lack of research and studies done on the kettlebell, a majority of the claims about significant gains in lean body mass, increased flexibility, and increased core strength and balance due to kettlebell workouts are still anecdotal. With the increasing popularity of the kettlebell as a fitness tool, more research needs to be completed on the outcomes of specific kettlebell workouts.
REFERENCES


