Original Research

The Effects of High Intensity Interval-Based Kettlebells and Battle Rope Training on Grip Strength and Body Composition in College-Aged Adults

JOSEPH MEIER*, JEFFREY QUEDNOW*, and TIMOTHY SEDLAK*

University of Wisconsin-Eau Claire

*Denotes undergraduate student author

ABSTRACT

International Journal of Exercise Science 8(2) : 124-133, 2015. The aim of this current study is to evaluate the changes in body composition and hand grip strength following high intensity interval training (HIIT) utilizing kettlebells and battle ropes. We hypothesize results will show that our HIIT protocol will improve grip strength and body composition. Subjects in the experimental and control group consist of 13 college-aged students (9 females; 4 males). Subjects in both groups complete a pre-test and post-test consisting of height, weight, grip strength via handgrip dynamometers and body composition via skinfold calipers. The experimental group completes a 5-week training session while the control continues their normal workout routines. Experimental group will undergo 5 weeks of HIIT for 3 sessions per week, consisting of a 20-minute protocol with an exercise work-to-rest ratio of 1:1 (15sec exercise; 15sec rest) alternating 2 minutes of kettlebell exercises with 2 minutes of battle rope exercises totaling four sets of each of the five exercises. To examine the group and time effects on grip strength and body comp results, a two-way repeated measured ANOVA and paired sample t-test was used. The only significant finding was in right handgrip strength (RHGS) which improved from 39.5kg±10.63kg to 42.08kg±11.45kg. There were no significant differences in body composition or left handgrip strength (LHGS). Our results suggest that HIIT using kettlebells and battle ropes does not elicit significant changes in body composition or LHGS over a 5-week period, although there were minor improvements in these measurements for the experimental group.

KEY WORDS: Low volume, exercise, resistance training

INTRODUCTION

High-intensity interval training (HIIT), also called high-intensity circuit training (HICT), has recently become a very popular tool in the fitness and rehabilitation setting to elicit many improvements such as changes in body fat, muscle strength and cardiovascular fitness in a short period of time. HIIT is a form of exercise utilizing alternating bouts of high-intensity exercise followed by a bout of low-intensity exercise or rest. It can be performed by using a wide variety of resistance or aerobic training equipment or by simply using one's own body weight. A major benefit to HIIT is the ability to maximize caloric expenditure in a minimalistic time period.

Only within the past decade has research been conducted more extensively to determine the benefits of this type of work-to-rest interval training. To obtain the positive effects of HIIT, rest time is an important factor to control for. During HIIT, heart rate stays elevated for the

duration of the workout leading to a higher level of oxygen consumption compared to traditional exercise. The shorter the rest period while completing HIIT, the higher the heart rate and oxygen consumption tends to be. A high level of oxygen consumption elicits greater physiological changes such as changes in body fat due to exercise post-oxygen consumption (EPOC) which is the body's way of restoring oxygen deficits from working out (17). It is imperative that rest periods are 30 seconds or less between exercises to result in the greatest metabolic impact, such that a greater caloric expenditure occurs leading to a greater rate of fat loss (5). Many studies use a 1:1 exercise-to-rest ratio typically resulting in 30 seconds of exercise and 30 seconds rest, but not many studies if any use 15:15 as will be done in this study to try to elicit positive effects on body composition and handgrip strength.

Another reason why HIIT is becoming a growing topic of interest is because of claims stating that it can reduce body fat in less time than the conventional steady-state exercise (10). Using similar volumes and frequency for low-intensity and high-intensity circuit groups, it has been found that using a higher intensity elicits a greater decrease in body fat (17). There is also a handful of research done on the aerobic effects of HIIT that suggests HIIT is effective at inducing improvements in aerobic fitness, and also increasing muscular endurance in a wide variety of muscle groups in as little as four weeks (9).

This style of training has also been found to provide many of the same affects as doing longer aerobic based workouts, even with resistance training as the modality. Evidence illustrates the effectiveness of high-intensity circuit training (HICT) in reducing fat mass, diastolic blood pressure, total cholesterol, LDL cholesterol, triglycerides, and ApoB as well as an increase in HDL cholesterol in men ages 61±3.3 years with a BMI of 29.8±0.9 (13). HICT has resulted in a positive effect on resting energy expenditure (REE); resting energy expenditure has shown to be higher in individuals that perform HICT compared to their resistance training counterparts. REE is the largest component of daily energy expenditure; therefore, positive effects of HICT on REE could potentially help researchers and practitioners in prescribing exercise regiments aimed to promote overall health, which may lead to effective weight management strategies (12).

Overtime, HIIT has been performed with a wide variety of workout equipment. However, there is little to no research done on the effects of using battle ropes or kettlebells. Battle ropes seem to be a promising new exercise tool, and in the near future will be getting more attention to their place in workout regimens. Another resistance tool, the kettlebell, has been utilized among practitioners, and kettlebell workouts have shown to improve strength, endurance, agility, and balance of both the muscular and cardiovascular systems with dynamic, total body movements (4). If kettlebell workouts can provide the benefits mentioned above, further research could provide data on their ability to help improve body composition as well.

Handgrip strength combined with cardiorespiratory fitness and nutrition are important determinants of motor fitness and skill-related fitness for musculature of the upper extremities (1). Handgrip

strength is also an important necessity for everyone, regardless of occupation since it is needed in everyday life without any conscious thought. Handgrip strength has been studied extensively in the past and has been found that poor handgrip strength is shown to increase the chances of the development of disability later in life, a decrease in functional ability, premature mortality, and an increased risk of complications as well as prolonging the length of stay after hospitalization or surgery (2, 15). By performing HIIT with kettlebells and battle ropes, handgrip strength may show improvement which would aid in preventing future health problems. Therefore, it is of interest to examine the effectiveness of HIIT training utilizing kettlebells and battle ropes on body composition and handgrip strength in college-aged adults.

The focus of the present study is to examine the effects that kettlebell and battle ropes-based high intensity interval training has on body composition and handgrip strength in young adults. Since kettlebells and battle ropes are exercise equipment that have not been frequently studied, this study could develop new information for the health fitness community. Based on previously read literature and experience using kettlebells and battle ropes, it is hypothesized that performing a 20-minute HIIT protocol consisting of kettlebells and battle ropes, three days per week over a five-week period will elicit positive changes in handgrip strength and body composition.

METHODS

Participants

Twenty-six physically active individuals were recruited by means of promotional flyers and word of mouth from the Eau Claire, Wisconsin area to participate in a HIIT study involving kettlebells and battle ropes. Only test volunteers that fulfilled the inclusion criteria and did not meet the exclusion criteria were included in the study. Inclusion Criteria: College-aged males and females 18-25 years old, history of regular exercise (self-reported exercise of at least 30 minutes of moderate-to-vigorous intensity exercise per day, 3-5 days per week for a total of 75-150 minutes per week). Exclusion Criteria: Individuals that have reported using kettlebells or battle ropes regularly in their workouts, recent injuries or persisting pains that would result in subject from doing certain exercises in the HIIT protocol, major competitive or life events that would prevent individuals from fully participating in workout routine, individuals below the age of 18 or over the age of 25.

Upon screening individuals based on the inclusion and exclusion criteria, approximately one dozen individuals were excluded from participating in the study due to age (3 individuals), injuries or limitations (2 individuals), not meeting activity guidelines (5 individuals) and reporting regular use of kettlebells and battle ropes (1 individual). Participants that met all requirements were selected to be in the HIIT study and were randomly assigned to a control group or an experimental group that would participate in the kettlebell and battle ropes workout. Participant characteristics of the control group included n=13 (4 males and 9 females), age 20.9 ± 1.0 years, height 168.1 ± 9.2 cm, weight 157.1 ± 50.3 lbs, body mass index (BMI) 24.9 ± 6.1 kg/m^2, body fat

percentage 20.8 ± 5.2%, right handgrip strength 38.6 ± 14.5 kg, left handgrip strength 37.8 ± 14.9 kg. Participant characteristics of the experimental/test group included n=13 (4 males and 9 females), age 20.2 ± 1.3 years, height 170.7 ± 13.5 cm, weight 158.8 ± 29.6 lbs, body mass index (BMI) 24.8 ± 4.3 kg/m^2, body fat percentage 22.5 ± 7.8%, right handgrip strength 39.5 ± 10.6 kg, left handgrip strength 36.8 ± 12.1 kg.

The study met all requirements of the institution's Institutional Review Board (IRB). Each participant was given a cover letter explaining what the study consisted of and was also explained verbally to them. Each participant also received an informed consent form that was approved by the IRB which was also verbally described to them in which they were also instructed to read over and sign if they still chose to participate in the study.

Protocol

Body composition was measured using Lange skinfold calipers (Lange skinfold caliper, Beta Technology Inc., Cambridge, Maryland). Body composition was measured at three sites which included subscapula, chest and triceps for male participants and triceps, suprailiac, and abdomen for female participants. Measurements were made according ACSM guidelines and procedures. Skinfold measurements were recorded to the nearest millimeter by a single skilled technician to avoid variability between testers. Three measurements were performed at each site and the median number was selected. Body fat percentage was calculated based on the Jackson-Pollock 1985 skinfold equation which is the reason why different sites were measured in females and males. Body composition was assessed using skinfold measurements because they are highly correlated with percent body fat in physically active and healthy individuals (12).

Handgrip strength was measured using Takei Kiki Kogyo handgrip dynamometers (Takei Kiki Kogyo handgrip dynamometer, Takei Scientific Instruments Co., Niigata, Japan). Grip strength was measured similar to what was done in a study by Bandyopadhyay with the exception of not using a three minute rest brake between trials (1). Subjects performed the grip test with arms down next to their side and would rotate testing between hands. Three measurements were taken on each side with the highest value being recorded to the nearest half kilogram.

Height was taken using a standard wall-mounted stadiometer. There was no brand name or company name on the device. Subjects were measured with backs against the wall and without shoes. A measuring platform was raised over subjects head and they were instructed to take a deep breath and step forward away from the stadiometer. Height was then recorded to the nearest tenth of a centimeter. Weight was measured using a Seca digital scale (Seca scale, Seca, Chino, California). Participants were instructed to stand on the scale without shoes on and with shorts and t-shirt as attire. Weight was recorded to the nearest tenth of a pound. From height and weight information obtained during baseline assessments, BMI was then calculated.

All eligible participants were notified to report to the exercise physiology lab at the institution during one of three time slots for

paper work processing and baseline assessments. They received a cover letter of the study ahead of time and were instructed to show up with shorts and a t-shirt. Subjects also were instructed not to exercise beforehand or put lotion on due to possible errors in skinfold measurements. During these initial baseline meetings, each subject was read to and explained the cover letter and informed consent form that was approved by the University of Wisconsin-Eau Claire's Institutional Review Board. After any possible questions and signing of the consent form, participants were notified of their randomly selected group (either experimental/test group or control group) which was altered for gender to make sure an equal number of females were in each group and an equal number of males in each group. They then were given an identification number, which would be used for all data collection and for confidentiality purposes. During this first visit, height, weight, handgrip strength and body composition was measured (details described above under Instrumentation) for both the experimental group and control group. Both groups were also given a nutritional data sheet to log their dietary intake. They were instructed to log everything containing calories three days per week which consisted of a random weekday, a workout day and a weekend day. A three day dietary recall of this nature is similar to what was done in a study by Porrata-Maury et al. (14). After all of this was completed, the control group was free to leave while the experimental group stuck around to run through a trial run of the HIIT protocol they would be performing the upcoming five weeks and sign up for a time slot to complete the workout.

The next participant-researcher meetings (weeks 2-6) consisted of performing the HIIT workout, which was done by the experimental group only and performed entirely within the campus fitness center. The workout consisted of a five minute warm-up, 20 minute HIIT workout, and five minute cool-down. Subjects participated in the workout three days per week (Monday, Wednesday and Thursday) for five weeks. The kettlebell and battle ropes HIIT protocol consisted of five kettlebell exercises using a kettlebell that was approximately 25% of the subject's body weight, and five battle ropes exercises for a total of ten different exercises. Weight of the kettlebell was set as25% of the subject's body to ensure proper technique for each of the exercises without compensatory movement, while also eliciting a desirable intensity. The kettlebell and battle ropes exercises are presented in Table 1.

Table 1. Kettlebell and battle rope exercises.

Kettlebell Exercises	Battle Ropes Exercises
Regular Swing	Alternating Waves
Swing with Goblet Squat	Jumping Jacks
Shovel	Parallel Waves
1-Armed Alternating Swing	Rotational Slam
Kettlebell Burpees	Jump Slam

Each exercise was performed for two minutes and consisted of four sets lasting 15 seconds each. For this study a 1:1 work to rest ratio was used in order to keep each session at a high intensity during the entire workout (7). So in this study's case, 15 seconds of HIIT was performed followed by 15 seconds of rest. After the four sets were completed (2 minutes), subjects rotated to the next station alternating kettlebell and battle ropes exercises and

repeated this process for the entirety of the 20 minute workout. Intensity for this study was monitored by using rate of perceived exertion (RPE). Subjects were told to aim for an 8-10 range on a 10 point scale.

All members from both experimental and control groups were notified to attend one of three post-test sessions (week 7). They were given the same instructions as the initial testing with what to wear etc. and were told to bring their completed nutritional data sheet. The same variables, height, weight, hand grip strength and body composition, were measured during this post-test.

Statistical Analysis

The current study is a true experimental design-experimental study consisting of a pre-test post-test randomized group design. There is control over the HIIT protocol consisting of kettlebells and battle ropes (independent variable) to see if any changes occur in handgrip strength and/or body composition (dependent variables). There were two levels of independent variables used. These include group variables of control group and experimental (HIIT group) and time variables of pre-test and post-test.

All data was scanned for plausibility prior to final evaluation to make sure no errors existed and all values were realistic. For statistical analysis, SPSS Version 19.0 software was used to employ a repeated measured ANOVA twice to account for both body composition and handgrip strength with a level of significance set at p=0.05. This statistical method will aid in answering if high-intensity interval training through the use of kettlebells and battle ropes can positively influence handgrip strength and body composition in the college-aged population.

Table 2. Participant characteristics (N=25).

Participant Characteristics	Mean	Standard Deviation
Age (years)	20.54	1.17
Height (cm)	169.41	11.39
Pre Weight (lbs)	157.95	40.48
Post Weight (lbs)	159.62	40.47

RESULTS

Subject characteristics and dependent variable measures are presented in table 2. We analyzed a total of 25 out of 26 possible subjects, with one subject being dropped from the study for personal reasons. Table 3 depicts changes in body fat percent and handgrip strength from pre- to post-test for the high intensity interval training group (HIIT) and control groups. To analyze the body fat percent data, we used a two-way repeated measures ANOVA using SPSS 19.0 software. There were no significant changes in body composition between the control group and HIIT group at significance level set at ($p<0.05$) as can be seen with the given interaction effect for body composition ($p=.517$) and group effect ($p=.590$).

We used a split file output to compare pre- and post-test differences for control and HIIT groups separately at significance level set at ($p<0.05$). This can be seen with the given interaction effect of left handgrip strength (LHGS) ($p=.887$) and group effect ($p=.139$). There were no significant changes in LHGS in either groups pre- to post-test. Right handgrip strength (RHGS) over the 5-week study from pre- to post-test showed a significant time effect ($p=.025$) in both groups and a significant increase ($p=.016$)

Table 3. Comparison of body composition and grip strength between pre- and post-test.

Measurement	Group	Pre-Test		Post-Test	
		Mean	SD	Mean	SD
BF (%)	Exp	22.46	7.81	22.00	7.45
	Control	20.67	5.43	20.83	6.39
RHGS (kg)	Exp*	39.50	10.63	42.08	11.45
	Control	39.42	14.85	39.92	17.03
LHGS (kg)	Exp	36.85	12.18	38.19	11.57
	Control	38.54	15.35	38.08	16.29

Note: *Indicates significant pre- to post-test difference at ($p<0.05$). SD=Standard Deviation, BF: Body Fat Percent, RHGS: Right Handgrip Strength, LHGS: Left Handgrip Strength.

in the HIIT group, but not in the control group. RHGS was calculated with a paired sample t-test to distinguish pre- to post- test differences between HIIT and control groups.

DISCUSSION

To the best of our knowledge, this is the first study comparing the effects of high-intensity interval training (HIIT) utilizing kettlebells and battle ropes on body composition and handgrip strength among college-aged active adults. We found no significant difference in body composition over the 5-week period, which does not align with our hypothesis or previous studies that investigated the effect of HIIT on body composition. However, in one specific study the subjects exercised for 50 minutes per session, three days per week, for 12 weeks total (13). Another study utilizing a high intensity running protocol 3-days per week for 8 weeks found insignificant improvements in body composition similar to our study (11). In our study, we utilized a 1:1 work to rest ratio similar to Romero-Arenas et al. (17) and Musa et al. (11), however, most studies used 30 seconds or greater for their work and rest periods, whereas we used 15 second work and rest periods. The shorter work and rest periods may have played a role in the insignificance of our body composition data. A weekly three day dietary recall was required of both the control and HIIT group participants for the duration of the study. This recall was a subjective measure to make participants aware of their food intake and so that we could make sure there were no major changes in diet from week to week. In future studies, counting calories more closely may be more beneficial in seeing greater results in body composition.

The most interesting finding with our study was a significant increase in RHGS among the HIIT and control group from a time effect over the 5-week period. Moreover, we ran a paired sample t-test, which showed that the HIIT group had a significant increase in RHGS, while the control group did not. The increase in RHGS was the only significant finding, and Bandyophadyaya (1) also had similar results in his subject's RHGS in relation to brick laying. It is possible that RHGS increased due to the training stimulus, or that the majority of subjects are RH dominant, and stimulating more use of the RH elicits larger improvements in RHGS.

Although statistically insignificant, LHGS slightly increased in the HIIT group, while it showed a decrease in the control group. This could potentially suggest the importance of incorporating battle ropes and/or kettlebell exercises to sustain grip strength, which may help to decrease the risk of disability later in life as was found in studies by Bohannon (2) and Rantanen (15). Although our study did not find significant improvements in LHGS and body composition, our HIIT group did show improvements compared to the control group. This shows that even with a very low volume of exercise (20 minutes, 3 days per week) improvements can be made.

This particular study had a variety of strengths and weaknesses. Its primary strength was the compliance of subjects throughout the duration of the study. Over all we had a 96% compliance rate among all subjects, and a 100% compliance rate among the HIIT group. These compliance rates are important, because they allow us to infer that had the study been a longer duration, results may have been more significant. Moreover, the largest weakness of this study was its overall duration, such that, particularly for body composition, five weeks may not have been an adequate amount of time to induce significant improvement, especially since subjects were already active. Another downfall was that a portion of our study fell on the week of spring break, so we lacked the ability to run the study for 5 weeks continuously. We also monitored our participant's dietary intake using a 3-day dietary recall each week of the study. Though there was not a drastic change in their reported diet, we did not account for caloric intake or macronutrients, which may have hampered some of our acquired results. The dietary recall may have also influenced the perception of some of the subject's eating habits, resulting in them changing their eating habits for the duration of the study to try and elicit better results. Ideally, administration of a valid dietary program in addition to the present training protocol is necessary for future studies. Overall, we believe the most important variable that can be manipulated is study duration, and we feel strongly that recreating this study with a longer duration could elicit better results. We also believe that performing this study with different populations such as subjects with poorer body composition at baseline, or older adults may elicit better results, as well as potentially show improvements in bone mineral density and energy expenditure.

Our results suggest that high-intensity interval training using battle ropes and kettlebells does not elicit significant improvements in as little as five weeks in body composition or LHGS; however, there was a significant improvement in RHGS and minor improvements in LHGS and body composition during our 5-week study. With our findings of improved HGS following kettlebell and battle rope HIIT sessions, this type of training can decrease the risk of disability later in life as was found in studies by Bohannon (2) and Rantanen (15). These studies found that poor HGS is associated with development of disability, decreased functional ability, and increased health complications later in life. HIIT utilizing kettlebells and battle ropes has the potential to be a valuable exercise tool due to its low-volume and high intensity protocol. While the results of this study did not fully correlate with our hypothesis, further investigation is needed explain the potential outcomes of this

training style over a longer duration (i.e. 8 continuous weeks or more). Further research should also be conducted on different populations such as sedentary individuals and elderly and the potential effects on bone mineral density and energy expenditure while using kettlebells and battle ropes. Even though all of the results from this study do not align with our hypothesis, we now have a better understanding of HIIT utilizing kettlebells and battle ropes, and their potential impact on improving grip strength and body composition.

ACKNOWLEDGEMENTS

The authors would like to acknowledge and thank Dr. Saori Braun and Dr. Jeffrey Janot for their constructive comments and suggestions for our research.

REFERENCES

1. Bandyopadhyay A. Body composition and hand grip strength in male brick-field workers. Malays J Med Sci 15(1): 31-36, 2008.

2. Bohannon RW. Hand-grip dynamometry predicts future outcomes in aging adults. J Geriatr Phys Ther 31(1): 3-10, 2008.

3. Corte de Araugo AC, Roschel H, Picano AR, Leito do Prado DM, Ferreira Villares SM, Lucia de Sa Pinto A, Gualano B. Similar health benefits of endurance and high-intensity interval training in obese children. PLoS ONE 7(8): 2012.

4. Crawford M. Kettlebells: Powerful, effective exercise and rehabilitation tools. J Am Chiropr Assoc 48(8): 7-10, 2011.

5. Haltom RW, Kraemer RR, Sloan RA, Hebert EP, Frank K, Tryniecki JL. Circuit weight training and its effects on excess post exercise oxygen consumption. Med Sci Sports Exerc 31(11): 1613-1618, 1999.

6. Kilpatrick M, Hebert E, Bartholomew J. College students' motivation for physical activity: Differentiating men's and women's motives for sport participation and exercise. J Am Coll Health 54(2): 87-94, 2005.

7. Klika B, Jordan C. High-intensity circuit training using body weight: Maximum results with minimal investment. ACSMs Health Fit J 17: 8-13, 2013.

8. Kravitz L. The fitness professional's complete guide to circuits and intervals. IDEA Today 14(1): 32-43, 1996.

9. McRae G, Payne A, Zelt JGE, Scribbans TD, Jung ME, Little JP, Gurd BJ. Extremely low volume, whole-body aerobic-resistance training improves aerobic fitness and muscular endurance in females. Appl Physiol Nutr Metab 37: 1124-1131, 2012.

10. Murphy E, Schwarzkopf R. Effects of standard set and circuit weight training on excess post-exercise oxygen consumption. J Strength Cond Res 6(2): 88-91, 1992.

11. Musa DI, Adeniran SA, Dikko AU, Sayers SP. The effect of a high-intensity interval training program on high-density lipoprotein cholesterol in young men. J Strength Cond Res 23(2): 587-592, 2009.

12. Paoli A, Moro T, Marcolin G, Neri M, Bianco A, Palma A, Grimaldi K. High-intensity interval resistance training (HIRT) influences resting energy expenditure and respiratory ration in non-dieting individuals. J Transl Med 10(237): 2012.

13. Paoli A, Pacelli QF, Moro T, Marcolin G, Neri M, Battaglia G, Bianco A. Effects of high-intensity circuit training, low-intensity circuit training and endurance training on blood pressure and lipoproteins in middle-aged overweight men. Lipids Health Dis 12: 131, 2013.

14. Porrata-Maury C, Hernández-Triana M, Rodríguez-Sotero E, Vilá-Dacosta-Calheiros R, Hernández-Hernández H, Mirabal-Sosa M, Campa-Huergo C, Pianesi M. Medium-and short-term interventions with Ma-Pi 2 macrobiotic diet in type 2 diabetic adults of Bauta, Havana. J Nutr Metab 2012: 2012.

15. Rantanen T, Guralnik JM, Foley D, Masaki K, Leveille S, Curb JD, White L. Midlife hand grip

strength as a predictor of old age disability. J Am Med Assoc 281(6): 558-560, 1999.

16. Richards JC, Johnson TK, Kuzma JN, Lonac MC, Schweder MM, Voyles WF, Bell C. Short-term spring interval training increases insulin sensitivity in healthy adults but does not affect the thermogenic response to the □-adrenergic stimulation. J Physiol 588(15): 2961-2972, 2010.

17. Romero-Arenas S, Martinez-Pascual M, Alcaraz PE. Impact of resistance circuit training on neuromuscular, cardiorespiratory, and body composition adaptations in the elderly. Aging Dis 4(5): 256-263, 2013.

18. Schnettler C, Porcari J, Foster C. Physiologic Responses to a Kettlebell Workout. University of Wisconsin – La Crosse. 2009.