Original Research

Eight Weeks of Kettlebell Swing Training Does not Improve Sprint Performance in Recreationally Active Females

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ABSTRACT

International Journal of Exercise Science 9(4): 437-444, 2016. The kettlebell swing (KBS), emphasizing cyclical, explosive hip extension in the horizontal plane, aligns with movement- and velocity-specificity of sprinting. The present study examined the effect of an eight-week KBS intervention on sprinting in recreationally-active females, in comparison to an eight-week intervention using the stiff-legged deadlift (SDL). Following a pre-testing session measuring 30 meter sprint and countermovement vertical jump performance, participants were divided evenly by sprint time into KBS (n=8) and SDL (n=10) cohorts. Following familiarization with the exercises, KBS met twice weekly to perform swings using the Tabata interval (20s work, 10s rest, 8 rounds), stressing a rapid, explosive tempo. In contrast, the SDL group performed their Tabata stiff-legged deadlifts at a conventional resistance training tempo (2 seconds concentric, 2 seconds eccentric). Following eight weeks and greater than 95% training adherence, the SDL group only had a slightly greater average training volume (~3%) than KBS. No significant differences in pre-test values, or changes were noted in sprint performance from pre- to post-intervention in either group. An improvement in vertical jump performance was noted across groups. Potential explanations for the lack of sprint improvement compared to previous studies include differences between recreationally-active and athletic females, and low exercise volume (~46% of a comparable study with improvements in vertical jump). Future studies should seek to determine the appropriate volume and intensity for KBS components of sprint programming.

KEY WORDS: Comparative study, resistance training, ballistic training

INTRODUCTION

Specificity is one of the foundational components of training success. In sport performance training, one of the initial steps in the design of an exercise regimen is the identification of movements specific to the needs of the individual, which may include joint angles, and muscle actions and recruitment (1, 4). This 'movement analysis' is an integral step in the selection of exercises that mimic sport-specific actions and transfer to competition. Furthermore, the intensity and movement velocity (explosiveness) utilized in the performance of an exercise can be a vitally important component of specificity (1, 4).

Sprinting, and the acceleration phase in particular, is characterized by the explosive extension of the hip, knee, and ankle joints (3), with a greater overall contribution of the hip joint particularly as speed increases (2). The kettlebell swing (KBS) is similarly characterized by activation of the posterior chain muscles, particularly in relation to the hip, in the horizontal plane that occurs during the sprint motion (3, 8, 11, 16) thereby indicating *movement* specificity. Additionally, the rapid concentric phase and ballistic nature of the KBS (8, 10) may align well with sprint performance, which also requires rapid force production. Comparisons between the KBS and a traditional one-repetition maximum back squat resulted in a greater impulse demand in the KBS, pointing towards the potential for a large rate of force development despite differences in load, and demonstrating the importance of the *velocity* of this exercise (8). Thus, it is likely that this *velocity* specificity would also align well with sprinting.

Despite the popularity and potential applicability of kettlebell training in multiple domains (7, 10, 13), the sport performance community has not responded with an appropriate depth of rigorous scientific studies into how kettlebell training may transfer into sprinting. In 2012, Lake and Lauder reported six weeks of two-handed KBS exercise progressing to 60% of maximal loads, improved maximal and explosive strength (7). Conversely, results from a comparison study suggested that KBS at ≤60% of maximal loads are not sufficient to develop lower body maximal and explosive strength, and concluded that the KBS may be best used as adjuvant training during a strength and conditioning program (8). Additionally, Otto et al. reported that six weeks of traditional weightlifting induced significantly greater improvements in strength compared with KBS training, however, both were effective in increasing muscular strength and power in recreationally-active men (13). Regardless of training modality, it is understood that volume plays an important role in the degree of muscular strength and power improvement. It is plausible that different training volumes used in the aforementioned studies may have resulted in ambiguous conclusions about the efficacy of KBS on power performance. Moreover, though hypothesized, it has yet to be determined whether KBS training can have positive effects on sprint performance (7). Therefore, the present study examined the effect of an eight-week KBS program versus a program of equal intensity, volume, and movement specificity using the stiff-leg deadlift (SDL) on sprint performance. The SDL was chosen as it utilizes very similar muscle recruitment as the KBS, while allowing a slower movement velocity (1, 4). In this fashion, it is possible to utilize similar *movement* specificity and volume, while addressing the additional *velocity* specificity of the KBS. Therefore, it was hypothesized that the eight-week KBS program would improve sprint performance to a greater degree than an eight-week SDL program.

METHODS

Participants

Twenty (n=20) healthy college-age female students (18-25 yrs) were recruited for the current investigation. Approval by the Slippery Rock University Institutional Review Board was acquired and all participants completed informed consent. Participants were instructed to maintain their current aerobic exercise and dietary programs throughout the duration of the study. No participants had extensive experience with kettlebell exercise or completed sprint or resistance training in the previous 6 months as a means to limit extraneous variables from prior training history. Study investigators, however, were trained in the safe and effective implementation of resistance exercise, and completed specific sessions on coaching the KBS and SDL. Participants were excluded from the present study if they were not cleared by their physician for vigorous exercise, were currently utilizing a resistance training program, were outside of the age range (18-25), or were unable attend the scheduled sessions.

Protocol

Participants were assigned into one of two groups (KBS or SDL) based on their initial sprint performance, to ensure that there were participants of similar ability in each cohort. Following the group assignment, participants were oriented to the training protocol. All participants participated in one instructional session on their assigned exercise prior to data collection. Technique mastery was not necessary during the single instructional session as the participants were observed (i.e. appropriate cueing) throughout the duration of the training intervention for both safety and effectiveness. Each group underwent an 8-week (twice-weekly) exercise intervention consisting of sixteen training sessions. Quite simply, this schedule was chosen as it fulfilled training frequency guidelines for beginners (i.e. 2-3 sessions per week), and fit within the time constraints of a university academic semester.

Each training session began with a 5 min light (<3 METs) aerobic warm-up on a treadmill followed by two 15 meter striders with a 30 second rest. All training sessions were performed using a Tabata interval timer (20 seconds of exercise; 10 seconds of rest; 8 rounds) based on previous work demonstrating a large anaerobic component to this training approach (5, 15). The participants were required to elect two non-consecutive days each week to exercise under the supervision of a project coordinator. Progressive overload was achieved through a combination of increasing volume and intensity. Load and repetition for each training session were recorded.

A 'hardstyle' kettlebell swing emphasizing maximal hip recruitment and minimal knee flexion was utilized in this study (7). Training started with a consistent prescribed weight (~9.1 kg) with the potential for a ~2.3 kg (next kettlebell weight increment) increase following week three, and another ~2.3 kg increase at week six, if the participant maintained proper form throughout each session. Form was monitored by trained instructors throughout the sessions, and included emphasis on maintaining an explosive concentric phase during maximal hip recruitment.

Training started with a consistent barbell weight (~27.3 kg), with the potential for a ~4.5 kg increase following week 3, and another ~4.5 kg increase at week 6, if the participant maintained proper form throughout each session. Form checks for the SDL group included the maintenance of a two-second up/two-second down exercise tempo and maximal hip recruitment.

Each participant completed both a 30-meter sprint test and countermovement vertical jump test on a consistent, indoor track. All participants were asked to give maximal effort for tests. Identical post-testing was completed between 48 and 72 hours of the final exercise session. If a participant performed the vertical jump test before the sprint test in pre-testing, they were asked to perform the sprint test first for post-testing. A minimum of five minutes was required between sprint and vertical jump testing.

Each participant performed the same warm-up during the pre- and post-training testing. This warm-up consisted of a 400-meter jog followed by a 40-meter interval of the following drills: high knees, butt kicks, walking knee-to-chest stretch, walking quad stretch, toe touches, hamstring swings, carioca, and striders. Participants were given the option to add additional warm-up striders before performing their maximal sprint ability. Thirty meter sprint performances were timed using a TC-Photogate (Brower Timing Systems, Draper, UT). Participants used a standing position and began the maximal sprint individually without a formal start. The TC-Photogate recorded when the participants crossed the start and the finish line. Each participant performed two sprint trials with a two-minute rest in between attempts, with the fastest sprint recorded.

A vertical jump measurement device (Vertec, Jump USA, Sunnyvale, CA**)** was used to measure maximal vertical jump height. Participants reached to maximum vertical height on the Vertec with their dominant arm while their feet were flat on the ground. Each participant performed two countermovement jumps with arm swing and displacement of the highest vane was determined. To calculate maximum vertical jump height, maximum vertical reach was subtracted from the highest vane displaced.

Statistical Analysis

All values are reported using the mean and standard deviation. All analyses were performed using a standard statistical software program (IBM SPSS Statistics for Windows, Version 21, 2012). Pre- and post-testing differences among groups were assessed using an independent t-test. A repeated measures ANOVA was utilized to assess potential differences in pre- and post-testing differences across groups. An a-priori α-significance level of ≤0.05 was accepted as a reflection of differences in the mean.

RESULTS

Eighteen healthy female participants completed the study. During the first week of training, one individual was removed due to an unrelated ankle injury; and following the eighth week of training, another individual withdrew due to an appendectomy. Pre- and post-testing data were recorded for eight KBS participants, and ten SDL participants. KBS had 95% adherence to the training intervention, with a total training volume of 15,850 swings. The average number of repetitions performed was 124, with an average training session volume-load of ~1378.2 kg. SDL had 96% adherence to the training protocol. However, only 6,746 SDLs were completed (due to the intentionally slower repetition velocity), with the average number of repetitions per training session at 43. Despite lower repetitions, average volume-load was similar ~1346.37 (3% >KBS).

There were no significant differences noted in the pre-training 30m sprint times between the KBS and SDL cohorts (Table 1, $P>0.05$). Likewise, there were no significant

Table 1. Comparison of pre- and post-training testing between groups.

	KBS		SDL		Combined	
Test	PRE	POST	PRE	POST	PRE	POST
Vertical Jump (m)	0.387±0.05	0.411±0.04	0.403±0.04	0.414±0.03	0.397±0.05	0.413±0.04*
Sprint (s)	5.16±0.24	5.17±0.26	5.17±0.26	5.23±0.21	5.17±0.25	5.20±0.25

All data are represented as mean ± standard deviation. *Significantly higher than PRE ($P<0.05$)

differences in the post-training 30m sprint times between the KBS and SDL groups (Table 1, $P>0.05$). In KBS or SDL pre- to post-testing sprint times were not significantly different (Table 1, $P>0.05$).

There were no significant differences noted in the pre-training vertical jump performances between the KBS and SDL groups (Table 1, $P>0.05$). Likewise, there were no significant differences in the post-training vertical jump performance between the KBS and SDL groups (Table 1, $P>0.05$). However, across groups, pre- to post-testing vertical jump performances improved by approximately 4% (Table 1, $P<0.05$), with no effect of training group.

DISCUSSION

To the knowledge of the authors, this is the first study to determine the effect of an 8-week KBS program versus a program of similar volume-load, and movement specificity using SDL on sprint and counter movement vertical jump performance. The primary finding in the current investigation was KBS training (8 week; 16 sessions) did not significantly increase sprinting performance when compared to SDL. Additionally, vertical jump performance was improved with training.

Due to the design of the study, no differences existed in pre-intervention sprint times or vertical jump heights between groups. The current investigation measured recreationally-active females who did not partake in resistance training activities. It is known that training status and modality can influence determinants of power (e.g. sprinting). Our recreationally-active cohort was not unusual in that they demonstrated similar average 30 meter sprint times for females when compared to those studied by Mangine and colleagues (5.2±0.2 v. 5.5±0.5 seconds) (9). Interestingly, no differences in the post-intervention sprint performances between KBS and SDL were observed. While both cohorts increased training loads and volumes over the course of the eight-week intervention, likely indicating adaptation, KBS training provided no additional transfer to the actions of sprinting, though a modest increase in countermovement vertical jump performance was observed.

To our knowledge, few investigators have attempted to quantify the efficacy of kettlebell exercise with equivocal findings. KBS has been reported to improve strength and power (7, 10), while another study has reported no additional benefit over traditional training (13). It is likely that improvements with KBS may be due to the cyclical, eccentric loading phase of the exercise combined with the rapid reversal of force necessary to transition to the concentric phase. Furthermore, the mechanical demand of the KBS is dictated by both a vertical and horizontal mechanical output (8), with a ballistic component provided by the long lever arm and variable center of mass of the participant/kettlebell system. Therefore, considering the movement- and velocity-specificity between KBS and sprinting, additional explanations for a lack of observed transfer in our findings must be considered.

The multifaceted nature of sprint performance must be considered first and foremost in the discussion of the current findings. Based on the duration of the training intervention, neural adaptations would likely account for a majority of the participants' ability to adapt to the training regimen and increase training volume (1, 12). Neural adaptations, while important, may not account for the spectrum of underlying changes necessary for improved sprint performance. It is likely that structural adaptations including muscle hypertrophy (3), increases in stride frequency and length, and enhanced sprint technique (12) are critical components of sprint performance, but were not addressed in this intervention.

The results of this study suggest that KBS training alone may not provide a sufficient stimulus to improve sprint performance in recreationally-active females even with a focus on movement and velocity specificity. It is likely that the present study may not have supplied a great enough training volume-load and intensity for improved sprint performance. In comparison to a study that demonstrated increases in explosive strength (vertical jump) in athletes using KBS (7), our training volume was likely inadequate. Assuming similar KBS movement and velocity specificity, when extrapolating an average training session from our study (<70kg subject; ~9.1 kg kettlebell; 15 swings/20 seconds; eight work intervals) to training parameters of similar work in athletes (<70kg subject; 12 kg kettlebell; ~22 swings/30 seconds; twelve work intervals), our trainees received only one-third of the average training session volume (7). Additionally, it is likely that the work to rest ratio (2:1) of the Tabata protocol resulted in muscular fatigue which limited participants from generating maximum power outputs throughout the exercise sessions. Thus, the drop in power output and relative intensity could limit the transferability of the intervention to sprint performance, which utilizes maximum power output. It is likely that an altered work to rest ratio (e.g. 1:4 or 1:5) would preserve movement quality and explosiveness to a greater degree than the Tabata protocol.

While athletes may respond differently to training, and pose greater challenges than their recreationally-active counterparts (12), it is probable that the volumes and intensities used in this investigation were underestimated. A conservative starting load was chosen for the KBS group, as the best current guidelines for power programming highlight the need for rapid force development (5). Consistent load assignment was deemed for this experiment in order to ensure similar training volume across participant groups, though it is likely that some means of individual strength or power testing in order to more accurately assign participant loads may have improved measured outcomes. Currently, however, specific load, intensity and volume recommendations for the various potential applications of the KBS are not readily available.

With the effectiveness of KBS training on vertical jump performance documented (7, 13), vertical jump was used as a comparable benchmark to gauge participant responsiveness to training. As countermovement vertical jump height changed significantly in both training cohorts (approximately 4% improvement) it is more likely that a lack of emphasis on sprint mechanics and technique may have had a larger impact on the lack of transfer to sprint performance than a simple lack of training volume.

Though correct form and adherence to the 'hardstyle' kettlebell swing and stiff-legged were coached across all 16 training sessions, it is likely that more familiarization sessions may have been beneficial to the participants. Additionally, while the scheduling of two 'nonconsecutive' training days per week was chosen purely out of a need for freedom in scheduling between the participants and investigators, a more rigorous schedule format may have altered the findings of the study. It is plausible that both sprint and jump performances are sensitive to diurnal variation (14). In the current study, scheduling conflicts resulted in a difference between pre- and post-testing time of day (12:00-2:00 PM and 7:00-9:00 AM, respectively). Furthermore, changes in the time of testing may have also impacted variables related to food consumption, hydration, body temperature, motivation, and sleep patterns.

In conclusion, an eight-week KBS program was not shown to improve measures of sprint performance when compared to an SDL program. Training volumes are an important consideration for effectiveness in interventions designed to improve sprint outcomes, however, an equal consideration must be placed on mechanics and technique. Due to movement- and velocity-specificity, the KBS should not be excluded from resistance training programs designed to accompany sprint training, especially given the limited volume of literature currently available. Recently, it has been reported that a two-handed KBS is appropriate for the training of ballistic or explosive outcomes (6). It is plausible that an appropriate KBS prescription as part of a comprehensive training program (e.g. teaching sprint technique) can improve sprint performance. However, data from the current investigation do not confirm or support the efficacious use of KBS in sprinting. Therefore, future research is still needed to determine the value of KBS in sprint-training programs and provide volume and intensity recommendations.

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