The Benefits and Drawbacks of Using Kettlebells in a Training Program

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Outline

• Educational Perspective and Scope of Presentation
• Muscle Activation – Landmark Study
• Kettlebells and Low Back Pain
• Kettlebells and Calories
• Kettlebells and Strength/Power Production
• Questions?
Questions That Will Be Answered

• What muscles are activated with kettlebell swings?
• What are the low back joint loads encountered during a 1-arm kettlebell swing?
• Can kettlebell swings improve low back pain?
• How many calories are burned during a kettlebell workout?
• Can kettlebell swings improve muscular strength and power production (vertical jump performance)?

Scope of Presentation

• What I can provide you (and what I cannot!)
• My goal is to challenge you
• You will be an expert on the scientific research of kettlebells

Scope of Presentation

• 12 scientific articles published on kettlebells
  – 2 Reviews
  – 2 Muscle Activation (1 on back loads)
  – 5 Muscular Strength & Power Production (vertical jump)
  – 2 Caloric Expenditure
  – 1 Musculoskeletal Health (low back pain)
Scope of Presentation

- All of the research articles that will be summarized are based on the fundamental movement of the kettlebell exercise:
  - 2-handed swing
  - 1-handed swing

Important Research Application Note

<table>
<thead>
<tr>
<th>Sedentary</th>
<th>Active</th>
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<tbody>
<tr>
<td>Complete Sedentary</td>
<td>Mostly Sedentary</td>
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<tr>
<td>Recreationally Active</td>
<td>Competitive Training</td>
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</table>

What Muscles are Activated with Kettlebell Swings?
What Muscles are Activated with Kettlebell Swings?

Kettlebell swing targets semitendinosus and supine leg curl targets biceps femoris: an EMG study with rehabilitation implications.


What Muscles are Activated with Kettlebell Swings?

• Objective: To investigate the medial (semitendinosus) and lateral (BF) hamstring muscle activation during the supine leg curl and kettlebell swing

What Muscles are Activated with Kettlebell Swings?

• Who was in the study?
  – 16 female elite handball and soccer players

• What was measured?
  – EMG activity of the lateral (biceps femoris) and medial (semitendinosus) hamstring muscle

• Results?
  – Kettlebell swing activated the ST ~20% more than the BF
  – Supine leg curl activated the BF ~20% more than the ST
Application

- The semitendinosus has the potential to prevent excessive dynamic valgus and external rotation of the knee joint during sports.
- Thus, specific training targeting the medial hamstring muscle seems important to avoid knee injuries.

What Muscles are Activated and to what Extent During a One-arm Kettlebell Swing?

What are the Low-back Joint Loads Encountered During a 1-arm Kettlebell Swing?

What Muscles are Activated During a 1-Arm Kettlebell Swing?

- Title: Kettlebell Swing, Snatch, and Bottoms-Up Carry: Back and Hip Muscle Activation, Motion, and Low Back Loads
- Authors: McGill SM and Marshall LW
- Citation: Journal of Strength & Conditioning Research 26(1): 16-127, 2012
What Muscles are Activated and what During a 1-Arm Kettlebell Swing?

• Purpose of Study:
  – Among others, the kettlebell swing was analyzed to determine:
    • Peak muscle activation (as a % MVC)
    • Average shear load of L4 on L5
    • Compressive spine loads at L4/L5

What Muscles are Activated During a 1-Arm Kettlebell Swing?

• Who was in the study?
  – 7 healthy males (~26 years) without back pain.
  – Most had kettlebell experience.

• What did they do?
  – All swings were conducted with a 16-kg kettlebell (right hand)
  – Muscle activation was obtained via EMG
    • Reported as a percent of maximal voluntary contraction (MVC)
  – Spine loading involved the use of 4-stage modeling process
    • Shear load of L4 on L5 and compressive spine loads at L4/L5

Kettlebell Swings – Muscle Activation

• The gluteal muscles experienced the greatest activation level:
  – Gluteus Maximus = 76% MVC
  – Gluteus Medius = 70% MVC
### Kettlebell Swings – Compression & Load

- Both shear and compressive loads were highest at the beginning of the swing.
  - 461 N of posterior shear of the superior vertebra of L4 on L5
  - 3,195 N of compression
- As a point of reference, a power clean of an Olympic bar from the floor with 27kg of weight on it creates a compressive load of 7,000 N.

### Table 1. Peak muscle activation of the back muscles, abductor adductor muscles, and right side gluteal and rectus femoris muscles together with the percentage of maximum values where they occurred during kettlebell swings.

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Peak Muscle Activation</th>
<th>Percentage of Peak</th>
<th>Swing</th>
<th>Swing</th>
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<tbody>
<tr>
<td>RLB</td>
<td>44.1</td>
<td>10.5</td>
<td>16</td>
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<td>FLB</td>
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</tbody>
</table>

### Table 2. Average compression and shear loads at the L4/L5 spine joint during kettlebell swings.

<table>
<thead>
<tr>
<th>Time</th>
<th>Compression (N)</th>
<th>Shear (N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start</td>
<td>3,195</td>
<td>2,960</td>
</tr>
<tr>
<td>Swing</td>
<td>2,909</td>
<td>2,486</td>
</tr>
<tr>
<td>End</td>
<td>1,903</td>
<td>1,290</td>
</tr>
</tbody>
</table>
Can Kettlebell Swings Improve Low Back Pain?

**Title:**  Kettlebell Training for Musculoskeletal and Cardiovascular Health: a Randomized Controlled Trial

**Authors:** Jay K, Frisch D, Hansen K, et al.

**Citation:** Scandinavian Journal of Work, Environment, & Heath. 37(3): 196-203, 2011

Can Kettlebells Improve Low Back Pain?

- **Who was in the study?**
  - People in an occupation with a high prevalence of musculoskeletal pain symptoms (sedentary office workers)
  - Everyone was asked to rate their pain in their low-back and in their neck/shoulder region

- **What did they do?**
  - Half did nothing
  - Other half performed kettlebell exercises 3 days/week for 8 weeks (~10-15 minutes)
How many calories are burned during a kettlebell workout?

Kettlebells and Calories

- Title: Oxygen Cost of Kettlebell Swings
- Authors: Farrar RE, Mayhew JL, Koch AJ.
- Citation: Journal of Strength & Conditioning Research 24(4): 1034-1036, 2010

Kettlebells and Calories

- Who was in the study?
  - 10 recreationally active college-aged men (~21 years) with no prior kettlebell experience

- What did they do?
  - Completed a 12-minute exercise bout consisting of performing 2-handed swings using a 16-kg kettlebell
  - Subjects wore a HR monitor and were connected to a metabolic cart to measure oxygen consumption
Kettlebells and Calories

• Subjects completed an average of 265 (± 68) swings during the 12-minute exercise bout.
  – 22 swings per minute

Kettlebells and Calories

• Relative VO₂ averaged 34 ml/kg/min
• This was equivalent to burning 160 calories in 12 minutes (for a 170 pound male)
  – 13 calories/min
• Although females were not tested in this study, a 130-pound female would have expended about 120 calories.
  – 10 calories/min

Kettlebells and Calories

• Average oxygen consumption was ~65% VO₂max
  – Exercise intensities at 65% VO₂max have been associated with maximal rates of fat oxidation (burning stored fat for energy).
• However, this particular exercise burned primarily carbohydrates for energy (RER = 1).
Kettlebells and Calories

- The metabolic data reported for the kettlebell exercise were of a similar pattern as circuit training.
  - High RER, moderate VO2

- This “man-maker” program imparts a greater challenge to the cardiorespiratory system than has been shown with traditional circuit weight training.
  - Average HR was 165 beats/minute or ~87% of maximum heart rate.
  - This relative heart rate was substantially higher than the relative oxygen consumption reported.

What Burns More Calories – Kettlebell Swings or Treadmill Running?

Kettlebell Swings vs. Treadmill Running

- Title: Comparison of Kettlebell Swings and Treadmill Running at Equivalent Rating of Perceived Exertion Values
- Authors: Hulsey CR, Soto DT, Koch AJ, Mayhew JL
- Citation: Journal of Strength & Conditioning Research 26(5): 1203-1207, 2012
Kettlebell Swings vs. Treadmill Running

• Purpose of Study: To compare the metabolic demand of 2-handed kettlebell swings with a treadmill run at an equivalent RPE.

• Who was in the study? 13 males and 2 females (~20 years) who were moderately trained but had no experience with kettlebells.

• What did they do? 10 minute kettlebell swing routine (35s/25s work:rest) 10 minute treadmill run at equivalent RPE

Kettlebell Swings vs. Treadmill Running

<table>
<thead>
<tr>
<th>Variable</th>
<th>Kettlebell swings</th>
<th>Treadmill running</th>
<th>NDiff*</th>
</tr>
</thead>
<tbody>
<tr>
<td>RPE (AVG)</td>
<td>15.3 ± 1.2</td>
<td>15.5 ± 1.3</td>
<td>1.1 ± 0.6</td>
</tr>
<tr>
<td>HR (bpm)</td>
<td>186 ± 12</td>
<td>177 ± 11</td>
<td>6 ± 9.7</td>
</tr>
<tr>
<td>VO₂ (L/min)</td>
<td>34.1 ± 4.2</td>
<td>46.7 ± 7.8</td>
<td>26.6 ± 9.9</td>
</tr>
<tr>
<td>METOLA</td>
<td>5 ± 4.6</td>
<td>10.5 ± 4.5</td>
<td>6.6 ± 4.6</td>
</tr>
<tr>
<td>RER (Vo₂/VCO₂)</td>
<td>2.06 ± 0.06</td>
<td>0.94 ± 0.04</td>
<td>-0.6 ± 0.6</td>
</tr>
<tr>
<td>Respiratory rate (breaths/min)</td>
<td>38.4 ± 3.3</td>
<td>38.2 ± 7.3</td>
<td>0.0 ± 18.3</td>
</tr>
<tr>
<td>Kcal/min</td>
<td>12.0 ± 2.5</td>
<td>17.1 ± 3.1</td>
<td>15.7 ± 0.4</td>
</tr>
<tr>
<td>Total kcal</td>
<td>209 ± 76</td>
<td>512 ± 115</td>
<td>279 ± 20.4</td>
</tr>
</tbody>
</table>

*NDiff = (Treadmill - Swing)/(Treadmill) × 100.

Can Kettlebell Swings Improve Vertical Jump?
Kettlebell Swings & Vertical Jump

- Title: Effects of Kettlebell Training on Postural Coordination and Jump Performance: A Randomized Controlled Trial
- Authors: Jay K, Jakobsen MD, Sundstrup E, et al.
- Citation: Journal of Strength & Conditioning Research (Published Ahead of Print)

Kettlebell Swings and Vertical Jump

- Who was in the study?
  - 40 people (85% female) in an occupation with a high prevalence of musculoskeletal pain symptoms (sedentary office workers)
- What did they do?
  - Half did nothing
  - Other half performed kettlebell exercises 3 days/week for 8 weeks (20 minutes)
    - 30 seconds of work followed by 30-60 seconds of rest

Figure 2: Illustration of the four progressions tried during the training sessions: (a) the unweighted swing, (b) double with a kettlebell, (c) 3-generator swing with a kettlebell, and (d) one-handed swing with a kettlebell.
Did Kettlebell Swings Improve Vertical Jump?

- In sedentary office workers (mostly female), a kettlebell training program did improve vertical jump performance:
  - Kettlebell group improved ~9%
  - Control group improved approximately 4%

Kettlebell Swings & Vertical Jump

- Title: Kettlebell Swing Training Improves Maximal and Explosive Strength
- Authors: Jason Lake and Mike Lauder
- Citation: Journal of Strength & Conditioning Research (Published Ahead of Print)

Kettlebell Swings & Vertical Jump

- Purpose of Study:
  - To determine if kettlebell swing training improves half squat strength and vertical jump
Kettlebell Swings & Vertical Jump

- Who was in the study?
  - 12 active men with at least 3 months of RT experience

- What did they do?
  - 2 times per week for 6 weeks:
    - ½ performed 12 rounds of KB swings (30s/30s work:rest) with a 12 or 16 kg kettlebell
    - ½ performed jump squat exercise (~3 sets of 3 jump squats) with a load that maximized peak power

Kettlebell Swings & Explosive Strength – Results

- No Difference Between the Groups for ½ Squat Strength
  - Kettlebell group improved ~12%
  - Weightlifting group improved ~8%

- No Difference Between the Groups for Vertical Jump
  - Kettlebell group improved ~15%
  - Weightlifting group improved ~24%

Important Research Application Note

Sedentary  Active

Complete Sedentary  Mostly Sedentary  Recreationally Active  Competitive Training  Elite-Training
Can Kettlebell Swings Improve Muscular Strength and Power?

Weightlifting vs. Kettlebells

• Title: Effects of Weightlifting vs. Kettlebell Training on VJ, Strength, & Body Composition
• Authors: Otto WH, Coburn JW, Brown LE, Spiering BA
• Citation: Journal of Strength & Conditioning Research 26(5): 1199-1202, 2012

Weightlifting vs. Kettlebells

• Purpose of Study:
  – To compare the effects of 6 weeks of weightlifting and traditional heavy resistance training vs. kettlebell training on strength and power.

• Who was in the study?
  – 30 healthy men (19-26 years) with ≥ 1 year of RT experience

• What did they do?
  – Each subject trained 2x/week for 6 weeks.
  – Vertical jump, 1RM Power Clean & Squat measured pre/post
The Programs

<table>
<thead>
<tr>
<th></th>
<th>Kettlebell Training (16-kg kettlebell)</th>
<th>Weightlifting Training (80% 1RM)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Weeks 1-3</td>
<td>Weeks 4-6</td>
</tr>
<tr>
<td>Kettlebell Swings</td>
<td>3 sets of 6 reps</td>
<td>4 sets of 6 reps</td>
</tr>
<tr>
<td>Accelerated Swings</td>
<td>4 sets of 6 reps</td>
<td>6 sets of 4 reps</td>
</tr>
<tr>
<td>Goblet Squats</td>
<td>4 sets of 6 reps</td>
<td>4 sets of 6 reps</td>
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</tbody>
</table>

Weightlifting vs. Kettlebells - Results

- No Difference Between the Groups for Vertical Jump
  - Kettlebell group improved ~1%
  - Weightlifting group improved ~4%

- No Difference Between the Groups for 1RM Power Clean
  - Kettlebell group improved ~4%
  - Weightlifting group improved ~9%

- Weightlifting Group was Significantly Better in 1RM Squat
  - Kettlebell group improved ~4.5%
  - Weightlifting group improved ~13.5%

Force & Power Production of 2-Hand Kettlebell Swings

- Title: Mechanical Demands of Kettlebell Swing Exercise
- Authors: Lake JP and Lauder MA
- Citation: Journal of Strength & Conditioning Research 26(12): 3209-3216, 2012
Force & Power Production of 2-Hand Kettlebell Swings

• Who was in the study?
  – 16 males (~24 years) with ≥ 6 months of kettlebell, back squat, and jump squat exercise experience

• What did they do?
  – 2 sets of 10 maximal effort swings with 16, 24, & 32 kg kettlebells
  – 2 back squats with 20, 40, 60, & 80% 1RM
  – 2 jump squats with 0, 20, 40, & 60% 1RM
  • Subjects were instructed to move the load of interest as quickly as possible using correct technique

Results – Relative to Body Mass

<table>
<thead>
<tr>
<th>Exercise</th>
<th>Peak Force (N/kg)</th>
<th>Peak Power (W/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kettlebell</td>
<td>21.5 (32 kg)</td>
<td>34.9 (32 kg)</td>
</tr>
<tr>
<td>Back Squat</td>
<td>28.4 (at 80% 1RM)</td>
<td>25.5 (at 60% 1RM)</td>
</tr>
<tr>
<td>Jump Squat</td>
<td>27.1 (at 40% 1RM)</td>
<td>41.3 (at 0% 1RM)</td>
</tr>
</tbody>
</table>

• Back squat and jump squat produced significantly more peak force than the kettlebell swing.
• Of the three exercises, peak force was maximized during back squat exercise with 80% 1RM.
• Of the three exercises, peak power was maximized during the jump squat with no added resistance.
Kettlebell Training, Strength & Power

• Title: Transference of Kettlebell Training to Strength, Power, and Endurance

• Authors: Manocchia, et al.

• Citation: Journal of Strength & Conditioning Research (Published Ahead of Print)

Purpose of Study:
- To determine if kettlebell training transfers strength and power to powerlifting exercises

Who was in the study?
- 37 males and females (18-72 years) who were resistance training for the previous 6 months

What was measured?
- 3RM Bench Press
- 3RM Clean and Jerk
- Maximal Vertical Jump

What did they do?
- Kettlebell training group performed kettlebell training 2 days per week for 10 weeks
- Control group did not perform any kettlebell exercises (continued daily activities and nutritional habits)
Kettlebell Training, Strength & Power

No improvement in vertical jump
What are the Benefits and Drawbacks of using Kettlebells in a Training Program?

Benefits and Drawbacks – New (i.e., sedentary) Client

• Benefits:
  – Improve lower back pain
  – Improve vertical jump (power production)
  – Improve lower body strength

• Drawbacks:
  – If the primary goal is to burn calories, the inclusion of kettlebells is not the best mode of activity
  – Technique driven skill and must be able to squat correctly
Benefits and Drawbacks – Advanced Client/Athlete

• Benefits:
  – Activation of the semitendinosus
    • Potential to prevent excessive dynamic valgus and reduce possible knee injuries

• Drawbacks:
  – Not as good of a tool as traditional resistance training for the following:
    • Muscular strength
    • Power Clean
    • Vertical Jump
    • Peak power production

Questions?