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The Science of Kettlebells: What Do We Know?
Questions That Will Be Answered

1. What is better for improving vertical jump, traditional weightlifting or kettlebell training?

2. What is better for improving strength, traditional weightlifting or kettlebell training?

3. What muscles are activated and to what extent during a one-arm kettlebell swing?
Questions That Will Be Answered

4. What are the low-back joint loads encountered during a one-arm kettlebell swing?

5. Is more peak force produced during a 2-handed kettlebell swing or during a jump squat?

6. Is more peak power produced during a 2-handed kettlebell swing or during a jump squat?
Questions That Will Be Answered

7. How many calories are burned during a 12-minute kettlebell swing exercise bout?

8. What is the role for kettlebell training in a rehabilitation program?

9. What burns more calories, kettlebell swings or treadmill running?
What is Better for Improving Vertical Jump & Muscular Strength - Traditional Weightlifting or Kettlebell Training?
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

### Kettlebell Training (16-kg kettlebell)

<table>
<thead>
<tr>
<th></th>
<th>Weeks 1-3</th>
<th>Weeks 4-6</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Kettlebell Swings</strong></td>
<td>3 sets of 6 reps</td>
<td>4 sets of 6 reps</td>
</tr>
<tr>
<td><strong>Accelerated Swings</strong></td>
<td>4 sets of 6 reps</td>
<td>6 sets of 4 reps</td>
</tr>
<tr>
<td><strong>Goblet Squats</strong></td>
<td>4 sets of 6 reps</td>
<td>4 sets of 6 reps</td>
</tr>
</tbody>
</table>

### Weightlifting Training (80% 1RM)

<table>
<thead>
<tr>
<th></th>
<th>Weeks 1-3</th>
<th>Weeks 4-6</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High Pulls</strong></td>
<td>3 sets of 6 reps</td>
<td>4 sets of 6 reps</td>
</tr>
<tr>
<td><strong>Power Cleans</strong></td>
<td>4 sets of 4 reps</td>
<td>6 sets of 4 reps</td>
</tr>
<tr>
<td><strong>Back Squats</strong></td>
<td>4 sets of 6 reps</td>
<td>4 sets of 6 reps</td>
</tr>
</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%
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?
Kettlebell Swings & Back/Hip Activation

• 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
Kettlebell Swings & Back/Hip Activation

• 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
Kettlebell Swings & Back/Hip Activation

• Who was in the study?
  – 7 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
TABLE 1. Peak muscle activation of the back muscles, abdominal wall muscles, and right side gluteal and rectus femoris muscles together with the percentage of movement cycle where they occurred during kettlebell swings. *

<table>
<thead>
<tr>
<th>Swing</th>
<th>Average peak muscle activation (%MVC)</th>
<th>Percentage of peak movement (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RLD</td>
<td>17.3</td>
<td>10.5</td>
</tr>
<tr>
<td>RUES</td>
<td>44.1</td>
<td>10.2</td>
</tr>
<tr>
<td>RLES</td>
<td>45.7</td>
<td>14.2</td>
</tr>
<tr>
<td>RGMAX</td>
<td>76.1</td>
<td>36.6</td>
</tr>
<tr>
<td>RBF</td>
<td>32.6</td>
<td>24.1</td>
</tr>
<tr>
<td>LLD</td>
<td>56.2</td>
<td>29.2</td>
</tr>
<tr>
<td>LUES</td>
<td>55.4</td>
<td>10.9</td>
</tr>
<tr>
<td>LLES</td>
<td>52.0</td>
<td>11.7</td>
</tr>
<tr>
<td>RRA</td>
<td>6.9</td>
<td>6.5</td>
</tr>
<tr>
<td>REO</td>
<td>16.5</td>
<td>12.9</td>
</tr>
<tr>
<td>RIO</td>
<td>42.4</td>
<td>42.5</td>
</tr>
<tr>
<td>RGMED</td>
<td>70.1</td>
<td>23.6</td>
</tr>
<tr>
<td>RRF</td>
<td>33.5</td>
<td>22.1</td>
</tr>
<tr>
<td>LRA</td>
<td>6.7</td>
<td>5.9</td>
</tr>
<tr>
<td>LEO</td>
<td>13.7</td>
<td>8.7</td>
</tr>
<tr>
<td>LIO</td>
<td>30.2</td>
<td>20.9</td>
</tr>
</tbody>
</table>

*RLD = right latissimus dorsi; RUES = right upper erector spinae; RLES = right lower erector spinae; RGMAX = right gluteus maximus; RBF = right biceps femoris; LLD = left latissimus dorsi; LUES = left upper erector spinae; LLES = left lower erector spinae; RRA = right rectus abdominis; REO = right external oblique; RIO = right internal oblique; RGMED = right glutes medius; RRF = right rectus femoris; LRA = left rectus abdominis; LEO = left external oblique; LIO = left internal oblique; MVC = maximal voluntary contraction.
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.
# Kettlebell Swings – Compression & Load

<table>
<thead>
<tr>
<th>Table 2. Average compression and shear loads at the L4/L5 spine joint during kettlebell swings.*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Compression (N)</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Average</td>
</tr>
<tr>
<td>Start</td>
</tr>
<tr>
<td>Middle</td>
</tr>
<tr>
<td>End</td>
</tr>
</tbody>
</table>

*The shear force represents the superior vertebra shearing posteriorly on the inferior vertebra.
Is more peak force produced during a 2-handed kettlebell swing or during a jump squat?

Is more peak power produced during a 2-handed kettlebell swing or during a jump squat?
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. Published Ahead of Print, 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
Force & Power Production of 2-Hand Kettlebell Swings

• What was measured:
  – Peak Force (absolute and relative to bodyweight)
  – Peak Power (absolute and relative to bodyweight)
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.
How many calories are burned during a 12-minute kettlebell swing exercise bout?
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 VO$_2$ 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% VO$_2$max
  – Exercise intensities at 65% VO$_2$max 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 is the Role for Kettlebell Training in a Rehabilitation Program?
Kettlebells in a Rehabilitation Program

- **Title:** Incorporating Kettlebells Into A Lower Extremity Sports Rehabilitation Program
- **Authors:** Brumitt J, Gilpin HE, Brunette M, et al.
- **Citation:** North American Journal of Sports Physical Therapy: 5(1): 257-265, Dec. 2010
Kettlebells in a Rehabilitation Program

Purpose of review is to outline the clinical rationale for the inclusion of kettlebell exercises when rehabilitating an athlete with a lower-extremity injury.
Kettlebells in a Rehabilitation Program

• The primary goal of a sports rehabilitation program is to return the injured athlete back to competition as quickly as possible.

• One component of an athlete’s comprehensive therapy program is the prescription of therapeutic exercises designed to restore and/or increase the following:
  – Range of motion
  – Strength
  – Power
Kettlebells in a Rehabilitation Program

• During the course of an athlete’s recovery, exercises that reproduce functional (or sport-specific) movement patterns should be prescribed.

• Including kettlebell exercises during the later stages of rehabilitation may provide an appropriate training stimulus that would help prepare the athlete for the physiological requirements of sport.
Kettlebells in a Rehabilitation Program

• 3 Phases of Healing:
  – Inflammation Stage
  – Repair & Healing Phase
  – Remodeling Phase
# Kettlebells in a Rehabilitation Program

<table>
<thead>
<tr>
<th>Phase (time)</th>
<th>Goal</th>
<th>Kettlebells Recommended?</th>
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<tr>
<td>Acute (1-4 days)</td>
<td>↑ ROM; ↓ Pain, Swelling</td>
<td>No</td>
</tr>
<tr>
<td>Reparative (4 days to 1 month)</td>
<td>↓ Pain; ↑ ROM, Strength</td>
<td>Yes</td>
</tr>
<tr>
<td>Remodeling (1 month to 1 year)</td>
<td>Restore functional movements; Sports-specific training</td>
<td>Yes</td>
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Kettlebells may be used (instead of dumbbells or barbells) to perform some traditional exercises, such as squats or lunges with 1 or 2 kettlebells.
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Kettlebells in a Rehabilitation Program

- This publication serves as a communication piece between the S&C staff and the Athletic Training staff in selecting exercises that facilitate the utilization of kettlebells.
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?
  – 11 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 2. Comparison of cardiovascular and metabolic variables for treadmill running and kettlebell swings (n = 13).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Kettlebell swings</th>
<th>Treadmill running</th>
<th>%Diff*</th>
</tr>
</thead>
<tbody>
<tr>
<td>RPE†</td>
<td>15.3 ± 1.2</td>
<td>15.5 ± 1.2</td>
<td>1.1 ± 3.0</td>
</tr>
<tr>
<td>HR (b·min⁻¹)†</td>
<td>180 ± 12</td>
<td>177 ± 11</td>
<td>0.6 ± 9.7</td>
</tr>
<tr>
<td>VO₂ (ml·kg⁻¹·min⁻¹)‡</td>
<td>34.1 ± 4.7</td>
<td>46.7 ± 7.3§</td>
<td>26.1 ± 9.9</td>
</tr>
<tr>
<td>METS‡</td>
<td>9.7 ± 1.3</td>
<td>13.3 ± 2.1§</td>
<td>26.2 ± 9.9</td>
</tr>
<tr>
<td>RER (VO₂/VO₂ max)‡</td>
<td>0.95 ± 0.05</td>
<td>0.94 ± 0.04</td>
<td>-0.6 ± 5.1</td>
</tr>
<tr>
<td>Respiratory rate (breaths/min)‡</td>
<td>36.4 ± 3.7</td>
<td>38.2 ± 7.0</td>
<td>2.0 ± 18.7</td>
</tr>
<tr>
<td>Kcal·min⁻¹‡</td>
<td>12.5 ± 2.5</td>
<td>17.1 ± 3.7§</td>
<td>26.7 ± 10.4</td>
</tr>
<tr>
<td>Total kcal‡</td>
<td>375 ± 76</td>
<td>512 ± 111§</td>
<td>37.9 ± 20.4</td>
</tr>
</tbody>
</table>

*%Diff = (Treadmill - Swing)/Treadmill × 100.
†Average of minutes 5, 7, 9, and 10.
‡Average of minutes 4–10.
§Significantly different at p < 0.01.
Kettlebells in the Workplace

• 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, & Health. 37(3): 196-203, 2011
Kettlebells and Frontal Plane Stability

- Title: Functional Training with the Kettlebell
- Author: Liebenson C.
- Citation: Journal of Bodywork and Movement Therapies. 15: 542-544, 2011
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Questions?