Exercise for Rehabilitation and Treatment:  
Summary of Research

Summarizing research findings to evaluate the effectiveness of exercise for rehabilitation and treatment of orthopedic conditions

Summary 14: Knee osteoarthritis  
November 2009

Q: In individuals with knee osteoarthritis, does the type of exercise influence outcomes as determined by the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC)?

To answer this question, we performed a comprehensive search of the PubMed database (June 2009) for randomized, controlled trials and systematic reviews that addressed this specific research question. ¹

Five studies met the criteria for inclusion in this review, comparing weight bearing to non-weight bearing exercise (¹); low to high-resistance exercise (²); water vs land-based exercise (³); kinesthesia and strengthening to strengthening-only (⁴); and isometric vs dynamic exercise (⁵).

All five studies included at least one subscale of the Western Ontario and McMaster Universities Index (WOMAC) as an outcome measure. This survey consists of three subscales for patients to self-evaluate knee function, pain, and stiffness during a range of daily activities (e.g., walking up and down stairs, rising from a chair). A total of 17 questions are included for knee function, 5 for pain, and 2 for stiffness with each being scored on a 5 point Likert-scale for a total score range of 0 (no pain or difficulty) to 96 (maximum pain or difficulty). Decreases in the score thus indicate improvement.

Three of the five reviewed studies showed significant improvement in WOMAC scores for both interventions with no differences between treatment groups: 8 wks of weight bearing or non-weight bearing exercise significantly improved function (¹); 8 wks of high-resistance or low-resistance leg press exercise significantly improved function and pain (²); and 18 wks of water-based or land-based lower extremity stretching and strengthening improved function, pain, and stiffness (³).

The remaining two studies found some differences between the treatments. The addition of kinesthesia and balance training to 8 wks of strengthening significantly improved function among women (⁴). Sixteen weeks of isometric or dynamic exercise resulted in significantly improved pain, while only dynamic exercise showed significantly improved function (⁵).

Based on this review, it can be concluded that a variety of exercise therapies can significantly improve outcomes for patients with knee OA. Sample exercises from VHI PC-Kits have been provided based on examples from these studies.

Knee Extension: Terminal - Standing (Single Leg) from VHI PC-Kits: Tubing, Lower Extremity #2

Tilt Board: Lateral Pivot from VHI PC-Kits: Balance Training, Unstable Surfaces #7
Table 1: Overview of Research Studies

<table>
<thead>
<tr>
<th>Study</th>
<th>Overview</th>
<th>Description of Intervention</th>
<th>Results &amp; Conclusions</th>
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<tbody>
<tr>
<td>1) Jan, 2009</td>
<td>Hypothesis/Aim: To compare the effects of weight bearing vs non-weight bearing for knee osteoarthritis (OA) among adults over 50 yrs of age.</td>
<td>Both groups completed exercise sessions 3x/wk for 8 wks. All subjects completed 4 x 6 reps at 50% 1-RM with 1 min rest between sets and 5 min rest between legs. Every 2 wks, 1-RM was increased by 5% as tolerated. Prior to exercise, subjects warmed up with 10 min of cycling and following exercise ice packs were applied for 10 min.</td>
<td>Outcome Measures: 1. Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC): The WOMAC function subscale was evaluated (see pg 1 of this newsletter for details). Results: After 8 wks, the change in knee function was significantly (p&lt;0.008) improved in the WB group (-10.3) and the NWB group (-17.2) as compared to the control group (0.2). There was no significant difference in the change in knee function between the 2 intervention groups. Of note, 3 subjects in the WB group and 2 subjects in the NWB group discontinued the intervention due to knee pain during exercise, while 4 participants in the WB group and 2 in the NWB group could not increase resistance beyond 60% of 1-RM. Conclusions: 8 wks of weight bearing or non-weight bearing knee extension exercise results in improved function among adults over the age of 50 with knee OA. However, neither exercise type appears to be more effective than the other.</td>
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<tr>
<td>Subjects: 106 adults (33 male; 73 female) meeting the following criteria: ≥50 yrs of age; bilateral knee pain meeting the American College of Rheumatology criteria for knee OA; pain &gt;6 mo in duration; OA &lt; grade 3 according to Kellgren/Lawrence; and without other knee conditions, unstable medical conditions, or current use of NSAIDS.</td>
<td>Non-weight bearing exercise: Subjects performed resisted knee extension and flexion in a seated position from 90° flexion to full extension at a speed of 90°/2 sec.</td>
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<td>Groups:</td>
<td>Control: Subjects performed no exercise during the study but were given the opportunity to participate in one of the exercise programs after the study was complete.</td>
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<tr>
<td>1. Weight bearing exercise (WB, n=36)</td>
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<td>2. Non weight bearing exercise (NWB, n=35)</td>
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<td>3. Control (n=35)</td>
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<tr>
<td>Duration: The length of the intervention was 8 wks. Assessments were completed at baseline and 3 days following the completion of the intervention.</td>
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</table>
Hypothesis/Aim: To compare the effects of high vs low resistance exercise for knee osteoarthritis (OA) among adults over 50 yrs of age.

Subjects: 98 adults (19 male; 79 female) meeting the following criteria: ≥50 yrs of age; bilateral knee pain meeting the American College of Rheumatology criteria for knee OA; pain >6 mo in duration; OA < grade 3 according to Kellgren/Lawrence; and without other knee conditions, unstable medical conditions, current use of NSAIDS, or physical therapy within the previous 3 mos.

Groups:
1. High resistance exercise (HR, n=34)
2. Low resistance exercise (LR, n=34)
3. Control (n=30)

Duration: The length of the intervention was 8 wks. Assessments were completed at baseline and 3 days following completion of the intervention.

Outcome Measures:
1. Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC): The WOMAC function and pain subscales were evaluated (see pg 1 of this newsletter for details).

Results: After 8 wks, pain subscale decreased significantly (p<0.008) in the HR group (8.5 to 4.8) and in the LR group (7.8 to 4.8) as compared to the control group (8.3 to 7.1). There was no significant difference in the change in pain subscale between the two intervention groups. The same results were seen for the change in function subscale, with a significant (p<0.008) improvement in the HR group (26.4 to 14.7) and the LR group (26.1 to 14.8) compared to the control group (25.4 to 22.5). Of note, there was no difference in function subscales between the 2 intervention groups. Of note, 3 subjects in the HR group discontinued the intervention due to knee pain during exercise and 3 could not tolerate more than 70% 1-RM.

Conclusions: 8 wks of high or low resistance knee extension exercise results in improved pain and function among adults over the age of 50 with knee OA. However, neither exercise type appears to be more effective than the other.

Hypothesis/Aim: To determine the effectiveness of water-based vs land-based exercise among patients with knee osteoarthritis (OA).

Subjects: 64 adults (5 male; 59 female) meeting the following criteria: clinical and radiological diagnosis of OA according to the All subjects completed 50 min group exercise sessions 3x/wk. The WBE group completed exercises in a heated pool while the LBE group performed exercises on a mat-covered floor. The same types of exercises for stretching and strengthening of lower extremities were used, with NSAID medication use controlled. Resistance was increased with bands or ankle weights on land and floaters or increased speed in the pool.

Outcome Measures:
1. Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC): The WOMAC function, pain, and stiffness subscales were evaluated (see pg 1 of this newsletter for details).
3) Silva, 2008

Examples of exercises include the following (modifications for water in parentheses): Supine single-leg raise with band around foot to maintain dorsiflexion (seated w/back against pool); supine straight-leg isometric dorsiflexion and plantar flexion (supine w/cervical and pelvic floaters); bridge exercise (standing hip extension facing wall with hand support); supine single-leg knee extensions from 30° flexion (standing legs lifts with back against side of pool); supine thigh abduction w/band above knees and supine thigh adduction with ball between knees (supine thigh abduction and adduction w/cervical and pelvic floaters).

Ten min of gait training included walking with high knees, side-to-side walking, and backward walking (same in water).

Results: After the intervention, the combined WOMAC subscale scores for pain, stiffness, and function improved significantly within both training groups (WBE 32.9 to 15.6, p<0.001; LBE 34.9 to 22.7, p<0.001). The significant improvement in WOMAC scores was evident by the 9th wk assessment (WBE 32.9 to 18.8; LBE 34.9 to 23.6). There was no significant difference between the groups in the WOMAC scores at any assessment time point (p=0.2). The authors noted a greater compliance with the water-based exercise program (96% vs 81%).

Conclusions: Water-based and land-based stretching and strengthening of the lower extremity are effective at improving pain, stiffness, and function among people with knee osteoarthritis. However, neither mode of exercise appears to be more effective than the other.

4) Diracoglu, 2005

Hypothesis/Aim: To determine the effect of adding kinesthesia and balance exercise to strengthening exercise among patients with knee osteoarthritis (OA).

Subjects: 60 women meeting the following criteria: 35-65 yrs; diagnosed with primary OA according to American College of Rheumatology; score >7 on the Lequesne Index; stage I or II bilateral knee OA according to Kellgren/Lawrence; and without secondary OA, active synovitis, serious knee trauma, or knee injection within prior 6 mos.

Groups: 1. Kinesthesia and balance exercise (n=30)

All subjects completed group exercise session 3x/wk for 8 wks.

Strengthening exercise: Subjects completed a program of stretching and strengthening for the quadriceps and hamstrings that began with range of motion and active stretching and progressed to include short-arc terminal knee extension, abductor and adductor isometrics, and hamstring isometrics. 3 x 10 reps of isometric exercises were completed at 50, 75 and 100% of 10-RM.

Kinesthesia, balance, and strengthening exercise: In addition to the strength protocol, subjects performed progressive balance exercises including the following: standing balance on hard and soft surfaces with eyes closed, walking on heels and toes, walking with eyes closed, 1-legged balance with multidirectional leaning with eyes open and closed, slowly sitting and rising from a chair, slow and fast walking in a circle, BAPS board balance exercises on 1 and 2.

Results: After the intervention, both groups showed significant improvements in the function subscales (p<0.05). Compared to strengthening only, the addition of kinesthesia and balance training resulted in a significantly improved function subscale (p=0.04).

Conclusions: The addition of kinesthesia and balance exercises to a standard strengthening program improves function among subjects with knee OA.
2. Strengthening exercise (n=30)

**Duration:** The length of the intervention was 8 wks. Assessments were completed at baseline and 8 wks.

Both exercise groups completed strength exercises 3x/wk for 16 wks (1 supervised; 2 at home). Exercises for both groups included the same progression, number of repetitions, and 6 muscle groups (ankle plantar and dorsiflexors, knee extensors and flexors, and hip extensors and flexors).

### Hypothesis/Aim:

To compare isometric and dynamic strength training among patients with knee osteoarthritis (OA).

### Subjects:

102 adults (28 male; 74 female) meeting the following criteria: knee pain score >5 on WOMAC pain subscale; physician diagnosis of OA of the knee; and without contraindications for exercise, current exercise level greater than 1hr/wk, knee pain due to cause other than OA, or underlying arthropathy of knee or pain in the low back, hips, or ankles.

### Groups:

1. Isometric exercise (n=32)
2. Dynamic exercise (n=35)
3. Control (n=35)

### Duration:

The length of the intervention was 16 wks. Assessments were completed at baseline and 16 wks.

5) Topp, 2002

### Outcome Measures:

1. **Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC):** The WOMAC function, pain, and stiffness subscales were evaluated (see pg 1 of this newsletter for details).

### Results:

After 16 wks, there were significant improvements (p<0.05) in both exercise groups for the pain subscale. Only the dynamic exercise group showed significant improvement (p<0.05) in the function subscale, while there were no significant improvements in the stiffness subscale for either group. No significant differences were present between the groups for any of the subscales. The control group did not show improvements on any of the subscales.

### Conclusions:

The authors concluded that resistance training programs using varying-levels of elastic resistance bands are effective for patients with knee osteoarthritis.

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**Table 2: Additional Exercises from VHI Exercise Kits**

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<tr>
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<td>Summary 14: Knee osteoarthritis</td>
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The exercises included in this newsletter are intended only as a sampling of exercises from the different VHI exercise collections that might be relevant to the topic discussed. Their inclusion in this newsletter does not represent any rehabilitation protocol or any suggested exercise progression that could be used with patients. Using the order of the exercises to create a rehabilitation program for patients is inappropriate and could result in serious injury.

### Table 2: Additional Exercises from VHI Exercise Kits (cont.)

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<thead>
<tr>
<th>Level: Beginning-Intermediate</th>
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<tbody>
<tr>
<td><strong>Kit</strong></td>
<td><strong>Tab</strong></td>
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<tr>
<td>Tubing</td>
<td>Rehab: Lower Extremity</td>
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### Level: Intermediate-Advanced

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<th>Exercise #</th>
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<td>Closed Chain</td>
<td>Lower Extremity</td>
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<tr>
<td>Kit</td>
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<tr>
<td>Balance Training</td>
<td>One-Leg Stand</td>
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<tr>
<td>Balance Training</td>
<td>Trampoline</td>
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**Summary 14: Knee osteoarthritis**

November 2009
Disclaimer

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References


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"Internet Delivery of Animated Rehabilitation Exercises"

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1 PubMed database was used to identify peer-reviewed research publications that addressed the specific clinical question (population, diagnosis, treatment, and outcome). For inclusion, studies must be a randomized controlled trial (RCTs) and published in English. A maximum of 10 RCTs were reviewed, with strength of design and publication year determining which studies to include.

2 No study footnotes needed.

3 Statistical definitions: 1) P-value (p) denotes the level of significance, where p<0.05 indicates a statistically significant result. 2) 95% Confidence Interval (95% CI): a range that contains the true population estimate 95% of the time. A smaller range indicates an estimate that is more precise. 3) Relative Risk (RR) is a ratio of proportions (ProportionTreatment / ProportionControl). RR less than 1.0 indicates the treatment group has a decreased risk of developing the condition/disease compared to the control group, while RR greater than 1.0 indicates the treatment group has an increased risk. 4) Incidence Risk Ratio (IRR) is the ratio of two incidence rates; the incidence rate among the treatment group divided by the incidence rate in the control group. IRR gives a relative measure of the effect of a given treatment with values less than 1.0 favoring the treatment. 5) Hazard Ratio (HR) is the relative likelihood of experiencing a particular event; an HR of 0.5 indicates that one group has half the risk of the other group. HR is broadly equivalent to RR, but is useful when the risk is not constant with respect to time as it uses information collected at different times. 6) Odds Ratio (OR) is the odds of an event happening in the treatment group expressed as a proportion of the odds of an event happening in the control group and can be interpreted similar to the RR. 7) Likelihood Ratio (LR) is the likelihood that a given test result would be expected in a patient with the target disorder compared to the likelihood that the same result would be expected in a patient without that disorder. The LR is used to assess how good a diagnostic test is and to help in selecting an appropriate diagnostic test(s) or sequence of tests.