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# Effective Exercises for Targeting the Gluteus Medius

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***Clinical Scenario****:* The gluteus medius (GM) is thought to play an important role in stabilizing the pelvis and controlling femoral adduction and internal rotation during functional activity. GM weakness, resulting in decreased stabilization and control, has been suggested to be related to lower extremity dysfunction and injury. Many clinicians focus on strengthening the GM to improve lower extremity kinematics for the prevention and rehabilitation of injury. An indirect way to measure GM strength is through electromyography. It is generally assumed that exercises producing higher levels of activation will result in greater strengthening effects.[3] Understanding what exercises result in the greatest level of GM activation will assist clinicians in their injury prevention and rehabilitation efforts. ***Focused Clinical Question****:* In a healthy adult population, what lower extremity exercises produce the greatest mean GM activation, expressed as a percentage of maximum voluntary isometric contraction?

***Keywords****:* electromyography, exercise, hip, strength

## Clinical Scenario

The gluteus medius (GM) is thought to play an important role in stabilizing the pelvis and controlling femoral adduction and internal rotation during functional activity.[1,2] GM weakness, resulting in decreased stabilization and control, has been suggested to be related to lower extremity dysfunction and injury.[1,2] Many clinicians focus on strengthening the GM to improve lower extremity kinematics for the prevention and rehabilitation of injury. An indirect way to measure GM strength is through electromyography (EMG). It is generally assumed that exercises producing higher levels of activation will result in greater strengthening effects.[3] Understanding what exercises result in the greatest level of GM activation will assist clinicians in their injury prevention and rehabilitation efforts.

## Focused Clinical Question

In a healthy adult population, what lower extremity exercises produce the greatest mean GM activation, expressed as a percentage of maximum voluntary isometric contraction (MVIC)?

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## Summary of Search, "Best Evidence" Appraised, and Key Findings

- The literature was searched for studies with a level of evidence 4 or higher that examined which lower extremity exercises produced the greatest mean GM activation expressed as a percentage of MVIC in healthy adults.
- The literature search produced 5 cross-sectional studies for inclusion; these were the only studies found that met all inclusion and exclusion criteria.
- Each study examined a variety of exercises including weight-bearing (WB), non-weight-bearing (NWB), single-leg, and double-leg exercises.
- Collectively, the exercises producing the greatest GM activation (in no specific order) were the single-leg squat, single-leg wall squat, pelvic drop, side bridge, and side-lying hip abduction.

## Clinical Bottom Line

In a healthy population, there is minimal evidence to support the use of the single-leg squat (with or without wall support), pelvic drop, side bridge, and side-lying hip-abduction exercises when aiming to maximize GM activation. These exercises produced the greatest mean GM activation in the 5 studies reviewed in this article. However, the quality of the evidence is low given the cross-sectional designs of these studies. It is difficult to strongly suggest these exercises given the quality of evidence, but based on the current literature available these are the exercises that appear to result in the greatest GM activation. If used, consideration should be given to issues such as injury history, functional ability, and strength of the surrounding core muscles when selecting exercises to implement and progress.

**Strength of Recommendation**: There is grade C evidence[4,5] that the WB exercises single-leg squat, single-leg wall squat, pelvic drop, and side bridge, in addition to NWB side-lying hip abduction, result in the greatest GM activation.

## Search Strategy

### Terms Used to Guide Search Strategy

- **P**atient/Client group: *adult* or *active* or *healthy*
- **I**ntervention/Assessment: *gluteus medius* and *exercise*
- **C**omparison: not applicable
- **O**utcome: *acti** or *activation* or *muscle activation* or *EMG* or *electromyography*

### Sources of Evidence Searched

- The Cochrane Library
- PEDro Database
- Medline
- CINAHL
- SPORTDiscus
- Additional resources obtained via hand search

## Inclusion and Exclusion Criteria

### Inclusion Criteria

- Studies that compared mean GM activation between 2 or more WB or NWB exercises
- Limited to the English language
- Limited to studies that reported mean EMG signal amplitudes of the GM normalized to MVIC
- Limited to the last 11 years (2000–2010)

### Exclusion Criteria

- Studies that included individuals younger than 18 years and older than 65 years
- Studies that included currently injured individuals
- Studies that measured GM subdivisions versus the GM as a whole
- Studies that compared aquatic exercises
- Studies that included an intervention other than, or in addition to, exercise (eg, vibration, orthotics, tape)

## Results of Search

Five relevant studies were located and categorized as shown in Table 1 (based on Levels of Evidence, Centre for Evidence Based Medicine, 2009).

**Table 1 Summary of Study Designs of Articles Retrieved**

| Level of evidence | Study design | Number located | Reference |
|---|---|---|---|
| 4 | Cross-sectional | 5 | Ayotte et al[6] |
| | | | Bolgla and Uhl[7] |
| | | | Boudreau et al[8] |
| | | | Distefano et al[9] |
| | | | Ekstrom et al[10] |

## Best Evidence

The studies in Table 2 were identified as the best evidence and selected for inclusion in this critically appraised topic (CAT). Reasons for selecting these studies were that they compared GM activation in a healthy population between 2 or more exercises that were WB or NWB and the main outcome reported was mean GM activation expressed as a percentage of MVIC.

## Implications for Practice, Education, and Future Research

GM activation occurred during all the exercises reviewed in this article, but to different degrees. Activation was greatest in the following exercises, ranked in descending order: side-lying hip abduction (81% ± 42% MVIC),[9] side bridge (74% ± 30% MVIC),[10] single-leg wall squat (72% ± 22% MVIC),[6] single-leg squat (64% ± 24% MVIC and 30% ± 9% MVIC),[8,9] pelvic drop (57% ± 32% MVIC),[7]unilateral bridge (47% ± 24% MVIC),[9] WB with flexed hip abduction (46% ± 34% MVIC),[7] forward step-up (44% ± 17% MVIC),[6] and lunge (19% ± 12% MVIC).[8]

For muscle-strength adaptations to occur, Andersen et al[3] suggest that neuromuscular activation be in the range of 40% to 60% of maximal effort. Most of the exercises identified herein fall within this range, indicating that they are sufficient exercises for strengthening the GM. The 2 exercises outside this range are the lunge, which activated the nondominant GM at 19% of its MVIC, and the single-leg squat reported by Boudreau et al,[8] which activated the GM at 30% of its MVIC. However, the single-leg squat reported by Distefano et al[9] activated the GM at 64% of its MVIC. Reasons for this large discrepancy may be differences in how the squat was performed or how MVIC was measured. In the Distefano et al[9] study, participants performed the single-leg squat by flexing until they could touch their contralateral middle finger to the outside of their WB foot without reaching with the shoulder. This may have posed a greater challenge in frontal-plane stability and thus increased GM activation in contrast to the participants in the Boudreau et al[8] study, who were instructed to squat down as far as possible and return to the starting position without losing

**Table 2 Characteristics of Included Studies**

| | Ayotte et al[6] | Bolgla and Uhl[7] | Boudreau et al[8] | Distefano et al[9] | Ekstrom et al[10] |
|---|---|---|---|---|---|
| Study design | Cross-sectional | Cross-sectional | Cross-sectional | Cross-sectional | Cross-sectional |
| Participants | 23 healthy, physically active Department of Defense beneficiaries (16 male, 7 female, 31.2 ± 5.8 y)<br>Included if 18–65 y, bilateral ROM within normal limits, bilateral lower extremity MMT strength 5/5, ability to perform single-limb balance with eyes open for 30 s<br>Excluded if had a history of surgery or disease of the spine or lower extremities, current pain or pathology in the spine or lower extremities, currently taking medication | 16 healthy participants (8 male, 8 female, 27 ± 5 y)<br>Included if had no lower extremity dysfunction and could perform a single-leg stance on each lower extremity<br>Excluded if had a history of significant lower extremity injury or surgery in the preceding year | 44 healthy individuals (22 male, 22 female, 23.3 ± 5.1 y)<br>Included if had no history of any major knee or hip injury, no history of surgery on either lower extremity, and were able to perform the 3 functional exercises being studied | 21 healthy, recreationally active participants (9 male, 12 female, 22 ± 3 y)<br>Included if reported participating in physical activity at least 60 min, 3 d/wk; no symptoms of injury at the time of testing; able to perform the exercises without pain; no history of ACL injury; and no recent (within the past 2 y) history of lower extremity surgery | 30 healthy participants (19 male, 11 female, 27 ± 8 y)<br>Included if had no current or previous lower extremity or back issues<br>Excluded if had low back or lower extremity pain or any recent surgery |
| Intervention investigated | 10-min cycle warm-up, electrode placement, practice/familiarization with the exercises, MVIC testing of the GM (side-lying position) and 3 other muscles<br>5 randomized single-leg WB exercises, 3 repetitions per exercise: wall squat, minisquat, and forward, lateral, and retro step-up | 5-min cycle warm-up followed by gentle lower extremity stretching, practice/familiarization with the exercises, electrode placement, MVIC testing of the GM (side-lying position)<br>6 randomized exercises (3 NWB, 3 WB), 15 repetitions per exercise—NWB: side-lying hip ABD, standing hip ABD, standing flexed hip ABD; WB: pelvic drop, left-hip ABD, flexed-left-hip ABD | Practice/familiarization with the exercises, 5-min cycle warm-up followed by static lower extremity stretching, electrode placement, MVIC testing of the GM-D, GM-ND (standing position), and 3 other muscles<br>3 randomized and counterbalanced WB exercises, 3 repetitions per exercise: lunge, single-leg squat, step-up-and-over | 5-min jog around a gym at submaximal speed as a warm-up, practice/familiarization with the exercises, electrode placement<br>12 randomized exercises, 8 repetitions per exercise—3 NWB: hip clams with 30° hip flexion, hip clams with 60° hip flexion, side-lying hip ABD; 9 WB: single-leg squat, single-leg dead lift, lateral band walks, multiplanar lunges (forward, sideways, transverse), multiplanar hops (forward, sideways, transverse); MVIC testing of the GM (side-lying position) and 1 other muscle | Practice/familiarization with the exercises, electrode placement, MVIC testing of the GM (side-lying position) and 7 other muscles<br>9 randomized exercises (repetitions per exercise not clearly stated): side-lying hip ABD, supine bridge, unilateral bridge (1 leg extended), side bridge, prone bridge, quadruped arm and opposite-leg lift, lateral step-up, standing lunge, Dynamic Edge (resistance to side-to-side motions simulating downhill skiing) |

*(continued)*

**Table 2** ***(continued)***

| | Ayotte et al[6] | Bolgla and Uhl[7] | Boudreau et al[8] | Distefano et al[9] | Ekstrom et al[10] |
|---|---|---|---|---|---|
| Outcome measures | Mean muscle activation normalized to MVIC | Mean muscle activation normalized to MVIC | Mean muscle activation normalized to MVIC (Note: authors call it a percentage reference voluntary contraction due to testing these muscles in nontraditional MVIC positions.) | Mean muscle activation normalized to MVIC | Mean muscle activation normalized to MVIC |
| Main findings | Mean GM muscle activation across the 5 single-leg exercises 52–36% MVIC and ranked in descending order as wall-squat, forward step-up, lateral step-up, retro step-up, minisquat<br>Significantly greater GM activation during the single-leg wall squat than the single-leg minisquat (*P* = .001), lateral step-up (*P* = .011), and retro step-up (*P* = .002) | Mean GM muscle activation across the 6 NWB and WB exercises 57–28% MVIC and ranked in descending order as WB pelvic drop, WB with flexed-left-hip ABD, WB left-hip ABD, NWB side-lying hip ABD, NWB standing hip ABD, NWB standing flexed-hip ABD<br>Significantly greater GM activation during the WB pelvic drop than the WB flexed-left-hip ABD, WB left-hip ABD, NWB standing hip ABD, NWB standing flexed-hip ABD (*P* < .003)<br>Significantly greater GM activation in the WB flexed-left-hip ABD, WB left-hip ABD, and NWB side-lying hip ABD than the NWB standing hip ABD, NWB standing flexed-hip ABD (*P* < .008) | Mean GM-D muscle activation across the 3 WB exercises 30–15% MVIC and ranked in descending order as single-leg squat, lunge, step-up-and-over<br>Mean GM-ND muscle activation across the 3 WB exercises 19–12% MVIC ranked in descending order as lunge, step-up-and-over, single-leg squat<br>Significantly greater GM-D activation during the single-leg squat than the lunge (*P* ≤ .017) and step-up-and-over (*P* ≤ .017)<br>Significantly greater GM-ND activation during the lunge than the single-leg squat (*P* = .006) | Mean GM muscle activation across the 12 exercises 81–38% MVIC and ranked in descending order as side-lying hip ABD, single-limb squat, lateral band walk, single-limb dead lift, sideways hop, transverse hop, transverse lunge, forward hop, forward lunge, clam with 30° hip flexion, sideways lunge, clam with 60° hip flexion<br>Significantly greater GM activation during side-lying hip ABD than both of the clam exercises, all 3 lunge exercises, the forward hop, and the transverse hop (*P* < .05) | Mean GM muscle activation across the 9 exercises 74–27% MVIC and ranked in descending order as side bridge, unilateral bridge, lateral step-up, quadruped arm–opposite-leg lift, hip ABD, Dynamic Edge, standing lunge, bridge, prone bridge<br>Significantly greater GM activation during the side bridge than all other exercises (*P* = .005)<br>Significantly greater GM activation during the unilateral bridge, lateral step-up, quadruped arm–opposite-leg lift, and hip ABD than the Dynamic Edge, standing lunge, bridge, and prone bridge (*P* = .05) |
| Level of evidence | 4 | 4 | 4 | 4 | 4 |
| Validity score | NA | NA | NA | NA | NA |
| Conclusion | The single-leg wall squat followed by the forward step-up elicited the greatest GM activation. | The WB pelvic drop followed by WB with flexed left-hip ABD produced the greatest GM activation. | The single-leg squat produced the greatest GM-D activation, followed by the lunge producing the greatest GM-ND activation. | The NWB side-lying hip-ABD exercises produced the greatest GM activation, followed by the WB single-leg squat. | The side bridge followed by the unilateral bridge exercises produced the greatest GM activation. |

ROM, range of motion; MMT, manual muscle testing; MVIC, maximal voluntary isometric contraction; GM, gluteus medius; WB, weight bearing; NWB, non-WB; ABD, abduction; D, dominant; ND, nondominant.

their balance. Furthermore, Boudreau et al[8] performed GM MVIC testing in a standing position, which may not have isolated the GM as well as the more commonly used side-lying position used by Distefano et al.[9]

Clinicians implementing exercises to strengthen the GM should consider incorporating the exercises identified in this CAT that fall within the range of 40% to 60% MVIC (side-lying hip abduction, side bridge, single-leg wall squat, single-leg squat, pelvic drop, unilateral bridge, WB with flexed-hip abduction, and forward step-up). Exercise selection should be based on various factors such as the patient's functional abilities, injury status, and overall core strength. For example, in patients rehabilitating a hip-abductor injury, it may be appropriate to begin with an exercise that requires less GM activation, such as the lunge, before progressing to exercises requiring greater activation. Similarly, depending on the patient's WB ability and biomechanics, clinicians may want to consider using the NWB exercises, particularly side-lying hip abduction, before progressing to the WB exercises.

It is important to note that EMG may not be a clinically relevant tool because of its cost, time involved, expertise required, and methodological limitations. If EMG is available for clinical use, careful placement of the surface electrodes is important to reduce variability within and across patients, which may decrease the likelihood of cross-talk between muscles. Cross-talk can particularly be an issue due to the proximity of the gluteus maximus and medius.[10] In addition, although the relationship between EMG amplitude and muscle force is thought to be generally linear during isometric contractions,[11] EMG is not a direct measure of strength and should not be used in isolation to monitor strength gains. Rather, EMG provides clinicians with insight regarding the level of activation of a particular muscle so a judgment can be made regarding the utility of the exercise to target the desired muscle during strengthening exercises.[10]

This CAT informs clinical practice by identifying which current and commonly used strengthening exercises are thought to most activate the GM. However, the lack of high-quality research investigating GM activation during various rehabilitative exercises highlights the need for prospective and randomized controlled trials that examine GM activation and strength gains over time in healthy and injured populations. Furthermore, future investigations examining the role of the GM subdivisions during preventive and rehabilitative exercises targeting the GM may also be clinically relevant. Limited research indicates that the anterior, middle, and posterior subdivisions of the GM may have different, yet synergistic, actions.[12] This CAT should be reviewed in 2 years to determine whether there is additional best evidence that may change the clinical bottom line for this clinical question.

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