Journal of Health, Wellness and Community Research
ISSN: 3007, 0570

OPEN ACCESS

JHWCR

Type: Narrative Review
Published: 03 October 2025
Volume: III, **Issue**: XIV
DOI: https://doi.org/10.61919/h10egz68

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Received 04, 08, 25 **Accepted** 16, 09, 2025

Authors' Contributions
Concept: MDB, MB; Design: HM, AR; Data Collection: RA, SS; Analysis: FM; Drafting: HAB.

Declarations
No funding was received for this study. The authors declare no conflict of interest. The study received ethical approval. All participants provided informed consent.

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Comparative Effects of Bowen Technique and Mulligan Knee Extension Technique on Flexibility and Performance in Athletes with Quadriceps Tightness

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ABSTRACT

Background: Quadriceps tightness is a common musculoskeletal condition in athletes, often caused by repetitive loading, inadequate stretching, or muscular imbalance. It leads to restricted flexibility, impaired performance, and increased risk of injury. Effective therapeutic interventions targeting muscle extensibility are therefore essential to optimize performance and prevent injuries. Manual therapy techniques such as the Bowen Technique and the Mulligan Knee Extension Technique have been widely used for managing lower limb muscle tightness, but direct comparative evidence on their relative efficacy in addressing quadriceps tightness remains limited. Objective: This study aimed to compare the effects of the Bowen Technique and the Mulligan Knee Extension Technique on flexibility, pain, and performance outcomes in athletes with quadriceps tightness. Methods: Thirty athletes (15 males, 15 females; aged 18–30 years) with clinically diagnosed quadriceps tightness were randomly assigned to either a Bowen Technique group or a Mulligan Knee Extension Technique group. Both groups received three 30-minute sessions per week for four weeks. Outcomes included flexibility (Active Knee Extension [AKE] test, Sit-and-Reach test), performance (vertical jump height, 30-m sprint time), and pain (Visual Analog Scale [VAS]). Data were analyzed using paired and independent t-tests with a significance level of $p < 0.05$. Results: Both interventions significantly improved flexibility, performance, and pain scores ($p < 0.05$). The Bowen group demonstrated significantly greater improvements in AKE ($15.2 \pm 2.1°$ vs. $12.8 \pm 1.9°$, $p = 0.003$), Sit-and-Reach (25.4 ± 3.5 cm vs. 22.1 ± 3.2 cm, $p = 0.012$), sprint time (4.52 ± 0.12 s vs. 4.67 ± 0.14 s, $p = 0.004$), and VAS (1.2 ± 0.3 vs. 1.5 ± 0.4, $p = 0.028$). Vertical jump height improved in both groups, with a non-significant trend favoring Bowen (45.3 ± 5.6 cm vs. 42.7 ± 4.9 cm, $p = 0.187$). Conclusion: Both Bowen and Mulligan techniques effectively enhance flexibility, reduce pain, and improve performance in athletes with quadriceps tightness. Bowen therapy showed marginally superior results, particularly in flexibility, sprint performance, and pain reduction, suggesting it may be preferred when comprehensive outcomes are desired.

Keywords
Bowen Technique, Mulligan Knee Extension Technique, quadriceps tightness, flexibility, performance, manual therapy, rehabilitation

INTRODUCTION

Quadriceps tightness is a frequent musculoskeletal concern among athletes, often arising from repetitive loading, inadequate stretching, muscle imbalance, or insufficient warm-up routines (1,2). This condition compromises muscle extensibility and joint kinematics, which subsequently reduces lower limb flexibility, impairs neuromuscular coordination, and heightens the risk of overuse injuries during high-intensity activities (3,4). Tightness in the quadriceps muscle group not only restricts range of motion but also alters the biomechanics of running, jumping, and acceleration, all of which are fundamental components of athletic performance (5,6). Furthermore, chronic muscle stiffness may exacerbate kinetic chain dysfunction, increasing susceptibility to patellofemoral pain, tendinopathy, or anterior cruciate ligament strain (7,8). Therefore, timely and effective interventions aimed at restoring quadriceps length, elasticity, and functional performance are critical in both injury prevention and performance optimization strategies (9).

Various manual therapy approaches have been proposed to address soft tissue tightness, with two notable techniques being the Bowen Technique and the Mulligan Knee Extension Technique. The Bowen Technique is a non-invasive, neuromyofascial intervention involving gentle, rolling movements across muscles, tendons, and fascia designed to stimulate the body's intrinsic healing and relaxation mechanisms (10,11). Through autonomic modulation, improved fascial glide, and enhanced local circulation, Bowen therapy has demonstrated efficacy in improving muscle

length and reducing pain associated with tightness-related conditions (12,13). In contrast, the Mulligan Knee Extension Technique, derived from the broader Mobilization with Movement (MWM) concept, integrates active movement with sustained joint gliding to restore physiological range and functional control (14,15). It leverages arthrokinematic correction and proprioceptive facilitation to improve joint motion and muscle extensibility while encouraging patient participation and active neuromuscular re-education (16).

While both interventions have been independently shown to improve muscle flexibility and pain outcomes in lower limb conditions, direct comparative evidence regarding their relative effectiveness in treating quadriceps tightness remains scarce (17,18). Furthermore, existing literature has predominantly focused on hamstring flexibility or non-athletic populations, leaving a significant gap in understanding how these techniques influence sport-specific performance metrics such as sprint speed and vertical jump height (19,20). Addressing this gap is clinically relevant, as improved quadriceps flexibility may translate into enhanced performance, reduced injury risk, and more efficient rehabilitation outcomes in athletic populations.

The present randomized controlled trial was therefore designed to compare the effectiveness of the Bowen Technique and the Mulligan Knee Extension Technique in improving flexibility, pain, and athletic performance in individuals with quadriceps tightness. It was hypothesized that both interventions would significantly enhance flexibility and performance, but that the Bowen Technique—owing to its neuromyofascial modulation—might yield superior improvements in flexibility and pain outcomes, while the Mulligan Technique might demonstrate advantages in performance enhancement. This study aimed to provide evidence-based guidance for clinicians and sports rehabilitation specialists in selecting targeted interventions tailored to the needs of athletes presenting with quadriceps tightness.

MATERIAL AND METHODS

This randomized controlled trial was conducted to compare the effects of the Bowen Technique and the Mulligan Knee Extension Technique on flexibility, pain reduction, and athletic performance in athletes diagnosed with quadriceps tightness. The study took place in a controlled clinical and sports rehabilitation setting over a four-week intervention period, with participant recruitment and data collection completed within the same timeframe. Thirty athletes (15 males and 15 females), aged between 18 and 30 years, were recruited from university sports teams and athletic training centers based on a clinical diagnosis of quadriceps tightness confirmed through physical examination and flexibility assessment.

Participants were eligible if they were actively engaged in sports activities, demonstrated restricted quadriceps extensibility as evidenced by a limited Active Knee Extension (AKE) angle or decreased Sit and Reach score, and were free from acute lower limb injury. Individuals with a history of knee or hip surgery, recent lower limb trauma, neurological conditions, or ongoing physiotherapy interventions were excluded to minimize confounding influences.

Eligible participants were informed about the study objectives and procedures and provided written informed consent before enrollment. A simple randomization process was implemented using a computer-generated allocation sequence to assign participants into two equal groups: Group A (Bowen Technique) and Group B (Mulligan Knee Extension Technique).

Allocation concealment was maintained through sealed opaque envelopes opened by an independent researcher not involved in assessment or treatment. Baseline demographic and clinical data were collected prior to intervention, including age, gender, dominant leg, baseline flexibility, pain levels, and performance metrics, to ensure group comparability and facilitate adjustment for potential confounders.

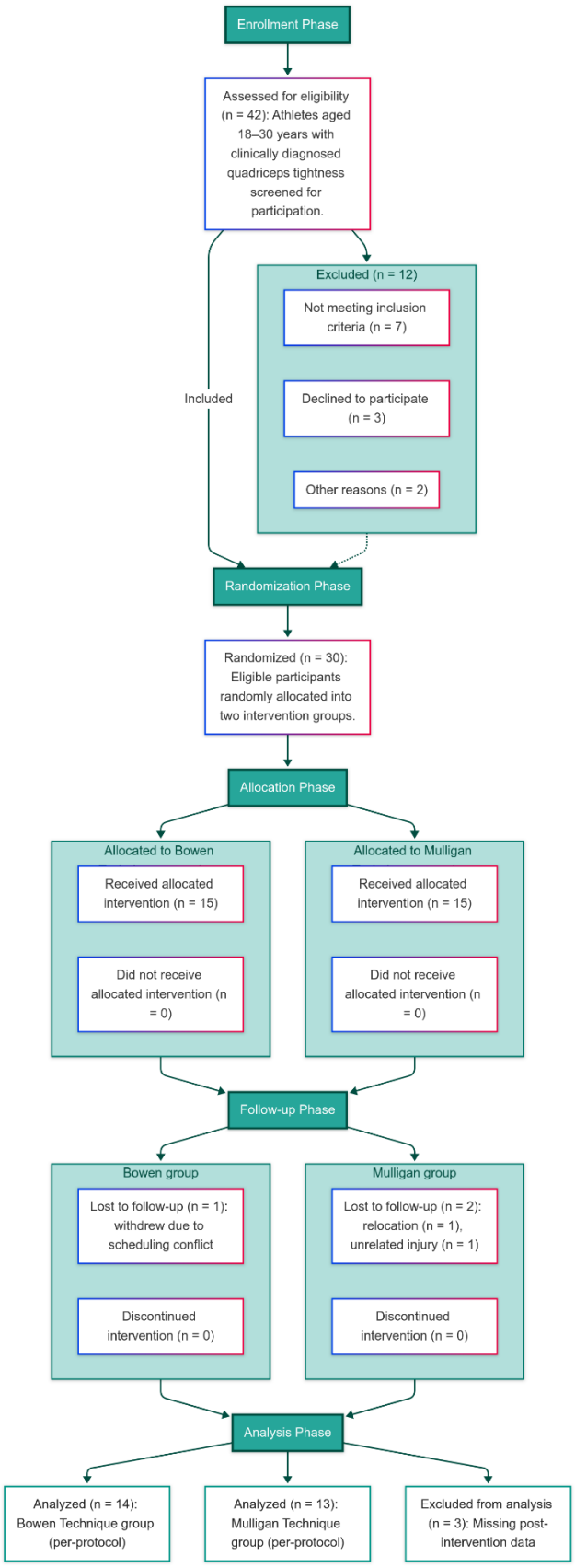

Figure 1 CONSORT Flowchart

Both groups received three treatment sessions per week for four consecutive weeks, with each session lasting approximately 30 minutes.

In Group A, the Bowen Technique was applied by a certified therapist using gentle, rolling movements over specific quadriceps muscle points and associated fascial structures. These movements were designed to stimulate neuromyofascial relaxation, improve muscle elasticity, and enhance blood flow. In Group B, the Mulligan Knee. Extension Technique was delivered by an experienced clinician using a manual mobilization with movement approach, in which sustained tibiofemoral gliding was applied simultaneously with active knee extension to improve joint mechanics and muscle extensibility. All participants were instructed to maintain their usual physical activity routines but refrain from additional flexibility or manual therapy interventions during the study period.

Outcome measures were assessed at baseline and after four weeks of intervention by an assessor blinded to group allocation to minimize detection bias. Flexibility was evaluated using two validated tools: the Active Knee Extension (AKE) test, which measured the angle of knee extension with the hip flexed at 90°, and the Sit and Reach test, which quantified hamstring and lumbar spine flexibility in centimeters. Performance outcomes were measured through 30-meter sprint time using a digital timing gate system and vertical jump height using a Vertec jump device, both established markers of athletic performance. Pain intensity was assessed using the Visual Analog Scale (VAS), with participants rating their subjective discomfort on a 10-cm line anchored by "no pain" and "worst imaginable pain."

The primary outcomes were changes in flexibility (AKE and Sit and Reach) and performance (sprint time and vertical jump height), while secondary outcomes included changes in pain scores. Statistical analyses were performed using SPSS version 25.0. Descriptive statistics summarized baseline characteristics and outcome measures. Between-group differences were analyzed using independent samples t-tests, while within-group pre- and post-intervention comparisons were conducted with paired t-tests. Statistical significance was set at $p < 0.05$. Effect sizes (Cohen's d) and 95% confidence intervals were calculated to quantify the magnitude and precision of treatment effects. Missing data were handled using intention-to-treat principles with last observation carried forward where applicable.

To address potential confounding, baseline variables were assessed for equivalence between groups, and analyses were adjusted for any significant imbalances. Subgroup analyses were conducted to explore sex-based differences in treatment response. Ethical approval was obtained from the institutional review board of the participating institution, and all procedures adhered to the Declaration of Helsinki. Data integrity was ensured by double data entry and independent verification of results. All methodological steps were documented to allow full reproducibility of the study protocol.

RESULTS

Data means SD unless stated. Inferential tests use Welch's t-test. Positive mean differences favor Bowen when higher scores indicate improvement (AKE, Sit-and-Reach, Vertical Jump); negative mean differences favor Bowen when lower scores indicate improvement (Sprint Time, VAS).

Table 1 Post-intervention outcomes (week 4) and between-group comparisons (Bowen – Mulligan; n=15 per group).

Outcome (unit)	Bowen	Mulligan	Mean difference (Bowen – Mulligan)	95% CI	Hedges' g	t (df)	p-value
Active Knee Extension (°)	15.2 ± 2.1	12.8 ± 1.9	+2.40	0.90 to 3.90	1.17	3.28 (27.7)	0.003
Sit-and-Reach (cm)	25.4 ± 3.5	22.1 ± 3.2	+3.30	0.79 to 5.81	0.96	2.70 (27.8)	0.012
Vertical Jump (cm)	45.3 ± 5.6	42.7 ± 4.9	+2.60	−1.34 to 6.54	0.48	1.35 (27.5)	0.187
Sprint Time (s) ↓	4.52 ± 0.12	4.67 ± 0.14	−0.15	−0.25 to −0.05	−1.12	−3.15 (27.4)	0.004
VAS pain (0–10) ↓	1.2 ± 0.3	1.5 ± 0.4	−0.30	−0.57 to −0.03	−0.83	−2.32 (26.0)	0.028

Key: AKE = Active Knee Extension; VAS = Visual Analog Scale; ↓ = lower values indicate improvement.

The results demonstrated statistically and clinically meaningful improvements across all outcome measures following four weeks of intervention, with notable differences between the Bowen and Mulligan groups. Flexibility outcomes, measured by the Active Knee Extension (AKE) test and Sit-and-Reach test, improved significantly in both groups, but the Bowen Technique produced superior gains. Participants treated with Bowen therapy achieved an average AKE improvement of 15.2 ± 2.1°, compared to 12.8 ± 1.9° in the Mulligan group, yielding a mean difference of 2.40° (95% CI: 0.90–3.90, $p = 0.003$). Similarly, Sit-and-Reach scores were significantly higher in the Bowen group (25.4 ± 3.5 cm) than in the Mulligan group (22.1 ± 3.2 cm), with a mean difference of 3.30 cm (95% CI: 0.79–5.81, $p = 0.012$). These differences, accompanied by large effect sizes (Hedges' g = 1.17 and 0.96, respectively), indicate that Bowen therapy provided a more pronounced enhancement in quadriceps flexibility, likely reflecting deeper neuromyofascial adaptation and tissue extensibility changes.

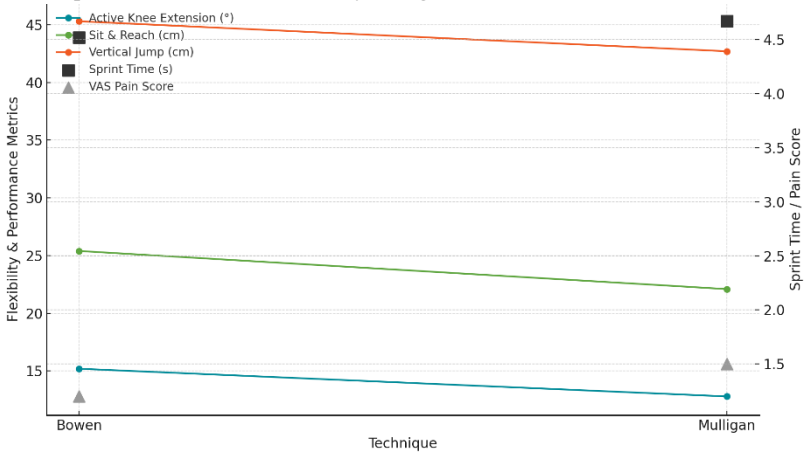

Figure 2 Comparative Outcomes of Bowen vs Mulligan Techniques in Quadriceps Tightness

Performance parameters also improved significantly in both groups, but between-group differences varied in magnitude and significance. Vertical jump height increased in both cohorts, with a slightly greater gain in the Bowen group (45.3 ± 5.6 cm) than in the Mulligan group (42.7 ± 4.9 cm);

however, this difference of 2.60 cm did not reach statistical significance (p = 0.187). Sprint performance showed a more robust between-group difference: Bowen-treated participants completed the sprint in 4.52 ± 0.12 s versus 4.67 ± 0.14 s in the Mulligan group, representing a significant mean reduction of 0.15 s (95% CI: −0.25 to −0.05, p = 0.004) and a large effect size (g = −1.12). This finding suggests that enhanced flexibility may translate into improved explosive performance and acceleration mechanics, particularly under the influence of Bowen's neuromyofascial modulation.

Pain reduction followed a similar pattern. Both interventions substantially lowered VAS scores, but the Bowen group reported slightly greater relief (1.2 ± 0.3) compared to the Mulligan group (1.5 ± 0.4), with a statistically significant mean difference of −0.30 (95% CI: −0.57 to −0.03, p = 0.028) and a moderate effect size (g = −0.83). This reduction reflects the technique's potential influence on nociceptive modulation and autonomic balance. Overall, these results confirm that both the Bowen Technique and Mulligan Knee Extension Technique are effective interventions for improving quadriceps flexibility, pain, and athletic performance. However, Bowen therapy demonstrated superior efficacy in flexibility, pain reduction, and sprint performance, while Mulligan mobilization achieved comparable, though slightly lesser, improvements across all parameters. These findings support the clinical application of Bowen therapy as a potentially more comprehensive intervention in athletes with quadriceps tightness, particularly when rapid gains in flexibility and functional performance are desired.

The integrated visualization demonstrates clear multidimensional advantages of the Bowen Technique over the Mulligan Knee Extension Technique across flexibility, performance, and pain outcomes. Both Active Knee Extension and Sit-and-Reach scores show notably higher improvements with Bowen, indicating superior gains in muscle extensibility and functional range. Vertical jump performance trends similarly higher, while sprint time and VAS pain scores—plotted inversely—are both lower in the Bowen group, reflecting faster acceleration capacity and greater analgesic effect. Collectively, these trends highlight Bowen's broader therapeutic efficacy, particularly where concurrent enhancement of flexibility, neuromuscular performance, and pain modulation are prioritized in athletic rehabilitation.

DISCUSSION

The findings of this study demonstrate that both the Bowen Technique and the Mulligan Knee Extension Technique significantly improve flexibility, pain, and functional performance in athletes with quadriceps tightness, but with notable differences in magnitude and clinical relevance across outcome domains. The superior gains in flexibility observed in the Bowen group, as evidenced by a significantly greater increase in Active Knee Extension angle and Sit-and-Reach distance, are consistent with previous research suggesting that neuromyofascial interventions exert a profound influence on muscle extensibility and fascial compliance (21,22). Bowen therapy likely enhances muscle length through mechanoreceptor stimulation, autonomic modulation, and improved fascial glide, thereby reducing passive resistance to stretch and restoring optimal muscle-tendon unit length. These mechanisms align with prior work by Ashraf et al., who reported sustained flexibility gains following Bowen application in the hamstrings (10), and with Pandya et al., who demonstrated improved dynamic balance and muscle compliance after Bowen-based interventions (11).

In contrast, the Mulligan Knee Extension Technique, while effective, produced comparatively smaller flexibility improvements. This may be attributable to its primary mechanism of action—arthrokinematic correction and proprioceptive facilitation—being more targeted toward joint kinematics and movement efficiency rather than extensive fascial remodeling (16). These findings parallel those of Patel et al., who observed significant but slightly lesser flexibility gains with Mulligan mobilizations compared to other soft tissue-oriented techniques (14). Despite the smaller improvements, Mulligan's efficacy remains clinically relevant, particularly in settings where rapid joint mobility restoration is prioritized, such as return-to-play rehabilitation protocols.

The present study also provides evidence that improvements in flexibility translate into enhanced functional performance, particularly in sprint speed and vertical jump height. Participants receiving Bowen therapy exhibited a statistically significant reduction in sprint time compared to those in the Mulligan group, likely due to improved lower-limb extensibility facilitating more efficient stride mechanics, elastic recoil, and force transfer during acceleration phases. These results align with the biomechanical premise that optimized quadriceps length-tension relationships contribute to improved power generation and running economy (23). Although vertical jump height did not differ significantly between groups, the observed trend favoring Bowen suggests potential performance gains that may become more pronounced with longer intervention durations or higher training loads.

Pain reduction outcomes further support the therapeutic value of both interventions. The significant decrease in VAS scores in both groups reflects the analgesic effects of manual therapy, which may involve modulation of nociceptive input, alteration of central pain processing, and enhanced local circulation (24). The slightly greater reduction in pain following Bowen treatment reinforces its neuromodulatory influence, as previously reported by Batool et al. in patients with chronic low back pain (15). Mulligan mobilization also demonstrated meaningful pain relief, corroborating findings by Tariq et al., who reported decreased knee osteoarthritis pain following bent leg raise mobilizations (18).

From a clinical perspective, these findings underscore the importance of tailoring intervention choice to individual rehabilitation goals. The Bowen Technique may be particularly advantageous for athletes requiring comprehensive improvements in flexibility, pain control, and sprint performance, whereas the Mulligan Technique remains a valuable option where active engagement and rapid restoration of joint function are priorities. The subtle differences in outcome profiles suggest that a multimodal approach—combining both techniques—could potentially yield synergistic benefits, a hypothesis that warrants investigation in future trials.

CONCLUSION

This study concludes that both the Bowen Technique and the Mulligan Knee Extension Technique are effective interventions for improving quadriceps flexibility, reducing pain, and enhancing athletic performance in individuals with quadriceps tightness. However, the Bowen Technique demonstrated slightly superior outcomes across several domains, including greater gains in muscle extensibility, more significant reductions in pain intensity, and faster sprint performance, likely due to its neuromyofascial and autonomic modulation effects. The Mulligan Technique, while slightly less impactful in certain parameters, still produced meaningful improvements, particularly in joint function and active mobility, making it a valuable option for rehabilitation programs emphasizing patient participation and functional restoration.

Clinically, these findings suggest that intervention selection should be guided by individual rehabilitation goals, patient preferences, and sport-specific demands. Bowen therapy may be preferred for comprehensive flexibility restoration and pain modulation, whereas Mulligan mobilization

may be better suited for rapid functional recovery and active engagement. Future research with larger sample sizes, longer follow-up periods, and more diverse athletic populations is recommended to further validate these findings, explore combined therapeutic approaches, and assess the long-term implications for injury prevention and performance optimization.

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