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Comparative Effect of Reciprocal Inhibition and Static Stretching Technique on Hip Flexion Range of Motion in Individuals with Iliopsoas Tightness

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ABSTRACT

Background: Iliopsoas tightness is common in individuals with prolonged sedentary exposure and may restrict hip extension, alter lumbopelvic mechanics, and contribute to compensatory movement. Reciprocal Inhibition (RI) and Static Stretching (SS) represent two different approaches to improving muscle length: RI uses an antagonist contraction to facilitate reflex relaxation of the iliopsoas, whereas SS relies on sustained passive mechanical elongation. Objective: To compare the effect of RI and SS on hip flexion range of motion, quantified through hip extension capability, in individuals with iliopsoas tightness. Methods: A randomized experimental pre-test/post-test comparative study included 30 participants aged 20–40 years with a positive Modified Thomas Test and sedentary occupations involving more than six hours of sitting per day. Participants were allocated equally to Group A (RI, n=15) and Group B (SS, n=15). Interventions were delivered for two weeks, six sessions per week. Hip extension ROM was measured with a universal goniometer in the Modified Thomas Test position. Paired and independent t-tests, Pearson correlation, chi-square analysis, and Cohen's d were used. Results: RI increased mean hip extension ROM from 171.42±3.25° to 185.24±2.88° (mean gain 13.82°, $p<0.001$), while SS increased ROM from 172.15±3.10° to 180.30±2.95° (mean gain 8.15°, $p<0.001$). The mean between-group difference in improvement was 5.67° ($p<0.001$). Post-treatment Modified Thomas Test negativity was 93.3% with RI and 46.7% with SS. Baseline ROM correlated negatively with BMI ($r=-0.684$) and daily sitting hours ($r=-0.742$), both $p<0.001$. Conclusion: Both techniques improved iliopsoas flexibility, but RI produced substantially larger ROM gains and a higher clinical normalization rate than SS over the two-week intervention period.

Keywords: Iliopsoas tightness; Reciprocal Inhibition; Static Stretching; Modified Thomas Test; hip range of motion; universal goniometry; sedentary behavior.

1. INTRODUCTION

The iliopsoas muscle complex forms an important mechanical connection between the axial skeleton and the lower extremities. The psoas major arises from the lumbar vertebral region and joins the iliacus before inserting at the lesser trochanter. Functionally, the complex is a powerful hip flexor and contributes to gait, femoral-head control, lumbar stability, and postural

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regulation. Because of its deep location and close relationship with the lumbar spine and pelvis, persistent shortening of the iliopsoas can influence movement well beyond the hip [1–3].

Prolonged sitting places the iliopsoas in a chronically shortened position. The thesis describes adaptive changes that may include reduced muscle extensibility, fascial restriction, altered sarcomere behavior, and increased neural sensitivity. Clinically, this may be expressed as restricted hip extension during the Modified Thomas Test. Persistent shortening may contribute to anterior pelvic tilt, increased lumbar lordosis, reduced gluteus maximus activation, and compensatory loading by the hamstrings and lumbar extensors. These mechanisms are particularly relevant in sedentary workers and people with prolonged desk-based occupations [4–7].

Static Stretching (SS) is one of the most commonly used flexibility interventions. The shortened muscle is passively elongated to a tolerable end range and held for a fixed period, allowing stress relaxation and increased tolerance to stretch. The thesis protocol used 30-second holds repeated four times per session. SS is simple, low-cost, and clinically accessible, but its effect may depend on sufficient dose and repeated exposure, and passive stretching may remain limited by protective neuromuscular responses [8,9].

Reciprocal Inhibition (RI) uses a different mechanism. Drawing on Sherrington's law of reciprocal innervation and principles used in proprioceptive neuromuscular facilitation and muscle energy techniques, RI asks the patient to contract the antagonist muscle. In this study, submaximal contraction of the hip extensors, particularly the gluteus maximus, was used to facilitate relaxation of the iliopsoas through spinal inhibitory pathways. This theoretically allows the therapist to move into a greater range after the contraction without relying on passive force alone [1,10,11].

The literature summarized in the thesis shows that both passive stretching and contraction-relaxation approaches can improve flexibility, but findings vary across muscle groups, populations, and intervention doses. Several reports suggest that neuromuscular techniques may produce faster or larger short-term gains, while others find broadly comparable improvements. Evidence specifically comparing RI with SS for iliopsoas tightness remains limited. The present study therefore compared the two techniques under a standardized two-week protocol and also examined Modified Thomas Test conversion, lifestyle correlations, sex-based response, and effect size.

2. AIM AND OBJECTIVES

The primary aim was to compare the effectiveness of the Reciprocal Inhibition technique and the Static Stretching technique on improvement of hip flexion range of motion, quantified through hip extension angle, in individuals with clinically identified iliopsoas tightness.

The specific objectives were:

- To evaluate the effect of Reciprocal Inhibition on hip extension range of motion in subjects with iliopsoas tightness.
- To evaluate the effect of Static Stretching on hip extension range of motion in subjects with iliopsoas tightness.
- To compare pre-intervention and post-intervention results within each group.

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- To compare the relative efficacy of RI and SS for increasing hip range of motion.
- To analyze the relationship of BMI and daily sitting duration with baseline hip extension ROM.
- To determine the clinical success rate of each technique in converting a positive Modified Thomas Test to a negative result.

3. MATERIALS AND METHODS

3.1 Study design and setting

The study used a randomized, experimental, pre-test/post-test comparative design. Participants who met the eligibility criteria were allocated by a computer-generated sequence to Group A (Reciprocal Inhibition) or Group B (Static Stretching). The investigation was conducted in the outpatient physiotherapy department of a multidisciplinary hospital under controlled clinical conditions.

3.2 Participants and sample size

Thirty participants were included, with 15 subjects in each group. The age range was 20–40 years. Initial screening used convenience sampling among hospital staff, local IT-office workers, and the surrounding community; eligible subjects were subsequently randomized to intervention groups. The study focused on sedentary individuals with prolonged sitting and clinically demonstrable iliopsoas tightness.

3.3 Eligibility criteria

Inclusion criteria were age 20–40 years, either sex, a positive Modified Thomas Test, hip extension ROM below 180°, and a sedentary occupation involving more than six hours of sitting per day. Exclusion criteria included recent spinal or hip surgery, radiating pain or neurological symptoms, acute trauma or fracture of the pelvis/hip/femur, systemic inflammatory disease, differential evidence of rectus femoris or tensor fasciae latae shortening, and pregnancy.

3.4 Outcome measurement

The primary outcome was hip extension range of motion in degrees. Participants were positioned in the Modified Thomas Test position at the edge of the treatment table. The contralateral hip was flexed until the lumbar spine was flattened against the table. Universal goniometry was performed with the fulcrum at the greater trochanter, the stationary arm aligned with the lateral axillary line of the trunk, and the movable arm aligned with the longitudinal axis of the femur toward the lateral femoral epicondyle. An angle below 180° represented tightness in the thesis protocol. Clinical outcome was also classified as Modified Thomas Test positive or negative.

3.5 Intervention protocol

Each participant completed a two-week intervention period with six sessions per week (Monday through Saturday).

Group A – Reciprocal Inhibition (RI):

- The participant was positioned supine at the edge of the table in the Modified Thomas Test position.

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- The therapist moved the tested limb into hip extension until the initial restrictive barrier was reached.
- The subject performed a submaximal isometric contraction of the hip extensors at approximately 20–30% of maximum effort by pushing the thigh downward against resistance.
- The contraction was maintained for 7–10 seconds with normal breathing.
- After relaxation, the therapist passively moved the limb to the newly gained extension barrier. The procedure was repeated three times per session.

Group B – Static Stretching (SS):

- The participant was positioned identically in the Modified Thomas Test position.
- The therapist passively extended the tested hip until a mild anterior hip/groin stretching sensation was reported.
- The stretch was held for 30 seconds, followed by 15 seconds of rest.
- The procedure was repeated four times per session, providing 120 seconds of total stretching time.


3.6 Statistical analysis

The thesis analyzed data using IBM SPSS Statistics Version 22.0. Descriptive statistics were reported as mean±SD. Paired t-tests assessed pre-to-post change within each group, independent t-tests compared mean ROM gain between groups, Pearson correlation evaluated relationships of BMI and daily sitting hours with baseline ROM, and chi-square analysis was used for categorical Modified Thomas Test outcomes. Statistical significance was set at $p<0.05$. Cohen's d was reported to describe the magnitude of treatment effects.

3.7 Ethical considerations

The study followed institutional ethical requirements and accepted principles for research involving human participants. Written informed consent was obtained before assessment and intervention. Participation was voluntary, confidentiality was maintained through coded

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identification, and treatment was discontinued for unusual pain, dizziness, or other clinically concerning discomfort.

4. RESULTS

Thirty-two participants completed the study, with 15 in each treatment group. Baseline demographic characteristics did not differ significantly between groups, supporting comparability before treatment.

Table 1. Baseline demographic characteristics

Variable	Group A (RI), n=15	Group B (SS), n=15	p-value
Age (years)	29.45 ± 4.32	30.12 ± 4.15	0.54
Height (cm)	168.2 ± 6.5	167.8 ± 7.1	0.82
Weight (kg)	72.4 ± 10.2	73.1 ± 9.8	0.78
BMI (kg/m²)	25.5 ± 3.1	25.9 ± 2.8	0.61

4.1 Within-group change in hip extension ROM

Reciprocal Inhibition produced a highly significant improvement in hip extension ROM. Mean ROM increased from 171.42±3.25° before treatment to 185.24±2.88° after treatment, a mean gain of 13.82° ($t=10.13$, $p<0.001$). Static Stretching also produced a significant improvement, from 172.15±3.10° to 180.30±2.95°, a mean gain of 8.15° ($t=6.96$, $p<0.001$).

Table 2. Pre- and post-intervention hip extension ROM

Group	Pre-intervention	Post-intervention	Mean gain	t-value	p-value
A – RI	171.42 ± 3.25°	185.24 ± 2.88°	13.82°	10.13	<0.001
B – SS	172.15 ± 3.10°	180.30 ± 2.95°	8.15°	6.96	<0.001

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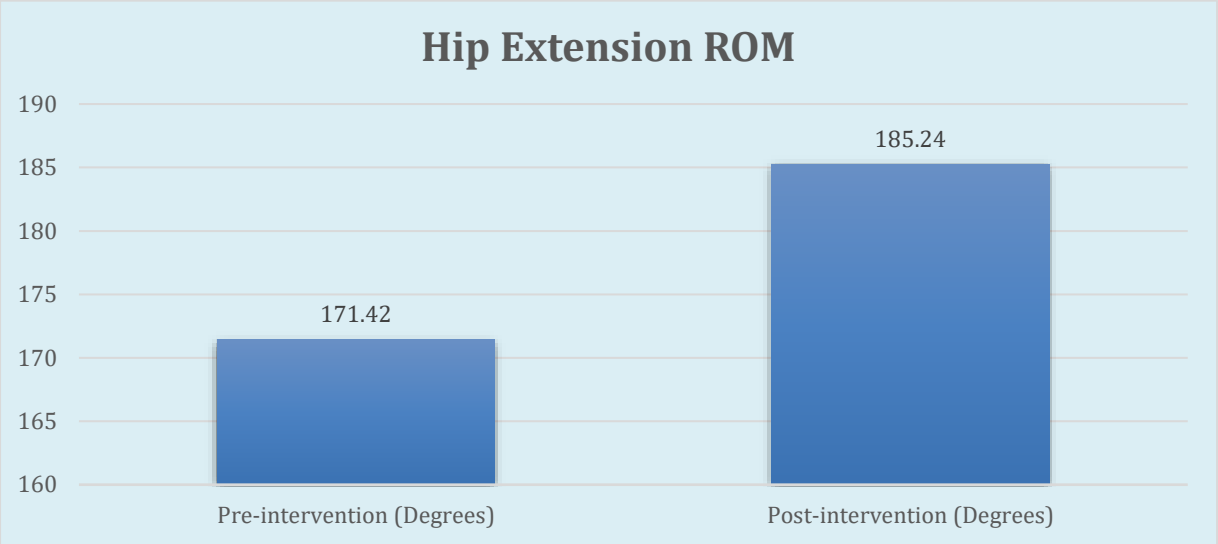

Figure 1. Pre- and post-intervention hip extension ROM in Group A (Reciprocal Inhibition)

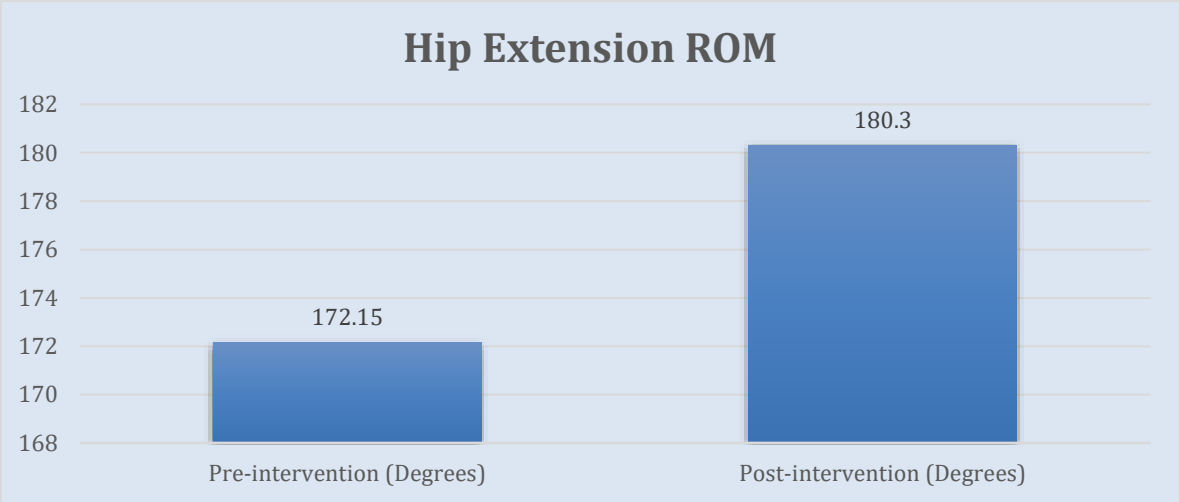

Figure 2. Pre- and post-intervention hip extension ROM in Group B (Static Stretching)

4.2 Between-group comparison of ROM improvement

The mean improvement was significantly greater in the RI group than in the SS group. The difference in mean gain was 5.67° and the thesis reported $t=7.05$ with $p<0.001$, indicating superior improvement with Reciprocal Inhibition over the two-week intervention period.

Table 3. Inter-group comparison of mean ROM improvement

Measurement	Group A (RI)	Group B (SS)	Mean difference	t-value	p-value
ROM improvement	13.82 ± 2.45°	8.15 ± 1.92°	5.67°	7.05	<0.001

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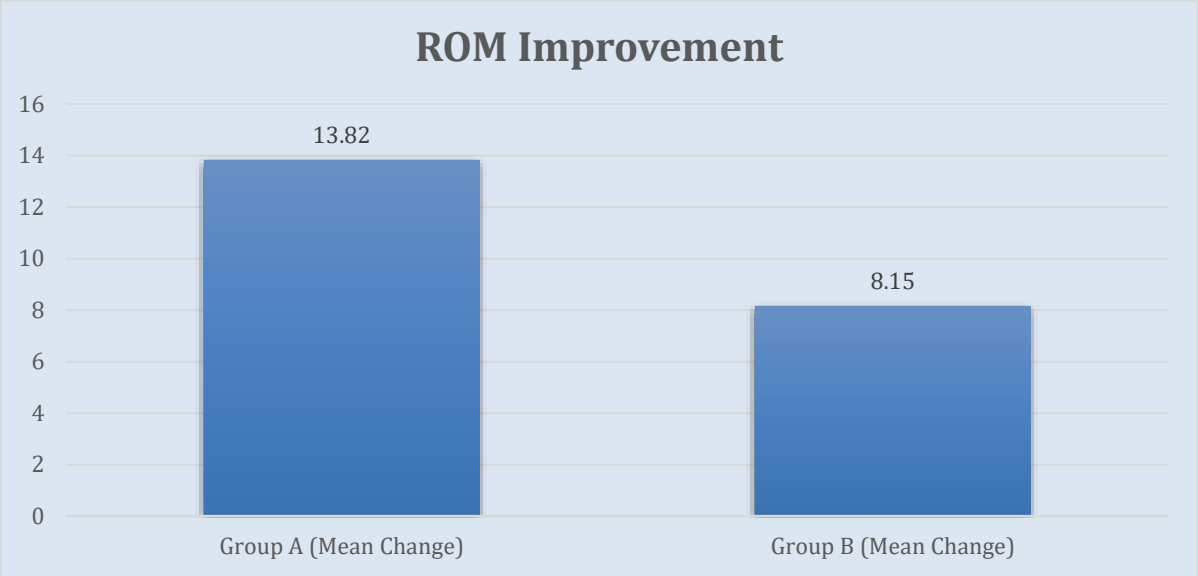

Figure 3. Mean improvement in hip extension ROM between Reciprocal Inhibition and Static Stretching groups

4.3 Clinical outcome: Modified Thomas Test

All participants had a positive Modified Thomas Test before intervention. At the end of treatment, 14 of 15 participants in the RI group (93.3%) converted to a negative test compared with 7 of 15 participants in the SS group (46.7%). Both groups showed significant clinical improvement, but normalization was markedly more frequent with RI.

Table 4. Modified Thomas Test clinical outcome

Group	Pre positive	Post negative	Success rate	χ^2	p-value
A – RI	15 (100%)	14 (93.3%)	93.3%	14.00	<0.001
B – SS	15 (100%)	7 (46.7%)	46.7%	7.00	0.008

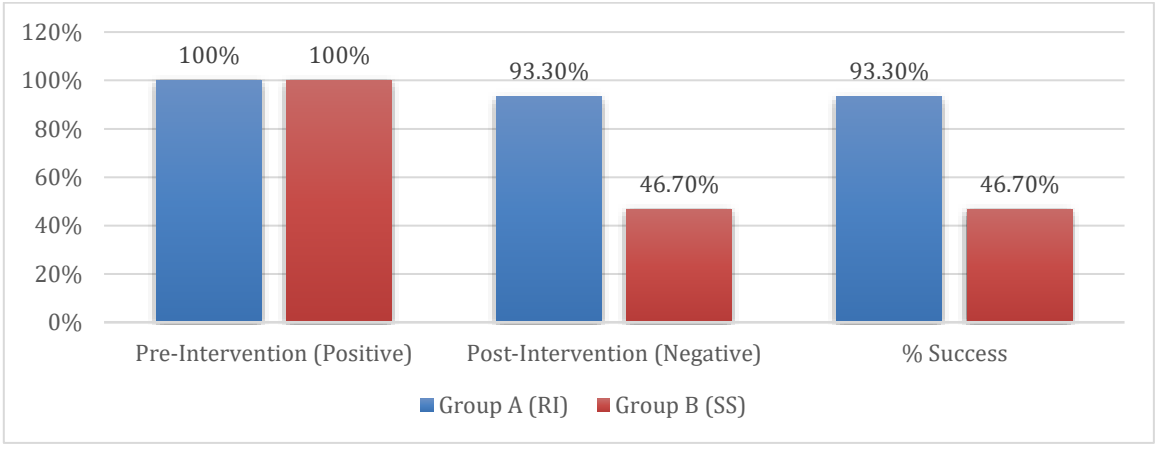

Figure 4. Post-treatment clinical success based on conversion to a negative Modified Thomas Test

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4.4 Lifestyle factors and baseline ROM

Baseline hip extension ROM showed significant negative relationships with both BMI and daily sitting exposure. Higher BMI was associated with lower baseline ROM ($r=-0.684$, $p<0.001$). Daily sitting hours showed an even stronger inverse relationship with baseline ROM ($r=-0.742$, $p<0.001$). These findings support the thesis interpretation that sedentary exposure and higher body mass are associated with greater iliopsoas restriction.

Table 5. Correlation of lifestyle factors with baseline hip extension ROM

Relationship	Mean ± SD	Pearson r	p-value
BMI vs baseline ROM	25.7 ± 2.9 vs 171.8 ± 3.2°	-0.684	<0.001
Sitting hours vs baseline ROM	8.42 ± 1.5 vs 171.8 ± 3.2°	-0.742	<0.001

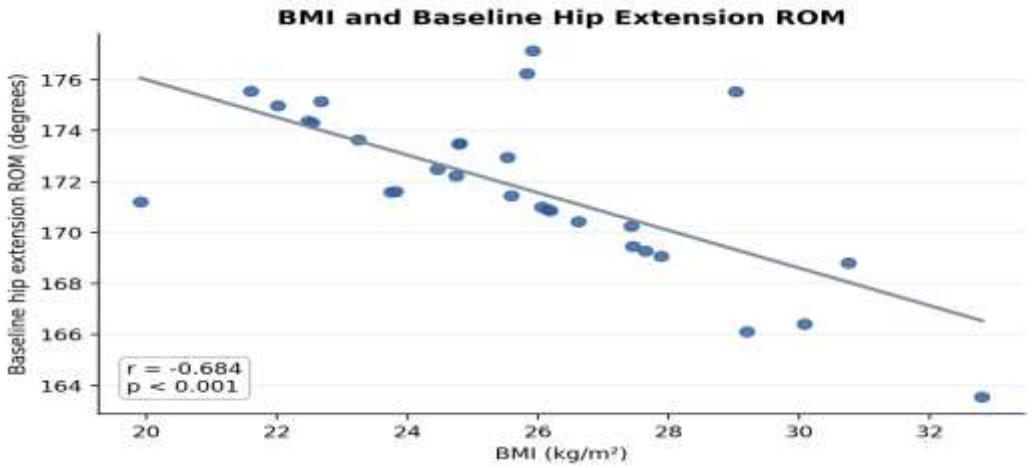

Figure 5. Relationship between BMI and baseline hip extension ROM based on the thesis master chart

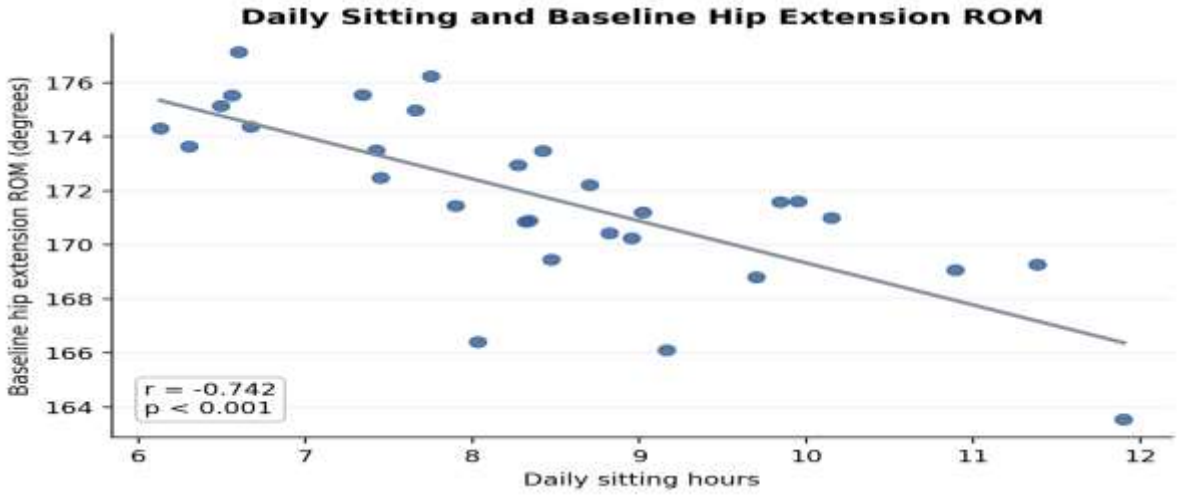

Figure 6. Relationship between daily sitting hours and baseline hip extension ROM based on the thesis master chart

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4.5 Sex-based response and effect size

Both male and female participants improved with treatment, and the RI group showed greater mean gains in each sex category. The thesis reported slightly larger gains among females, while describing no meaningful sex-specific limitation to the response. Effect-size analysis demonstrated a very large within-group effect for RI (d=4.49), a large effect for SS (d=2.69), and a large between-group effect for treatment gain (d=2.58).

Table 6. ROM improvement by sex

Sex	RI mean gain	SS mean gain	t-value	p-value
Male (n=13)	13.1 ± 2.2°	7.8 ± 1.8°	6.54	<0.001
Female (n=17)	14.4 ± 2.6°	8.4 ± 2.1°	7.12	<0.001

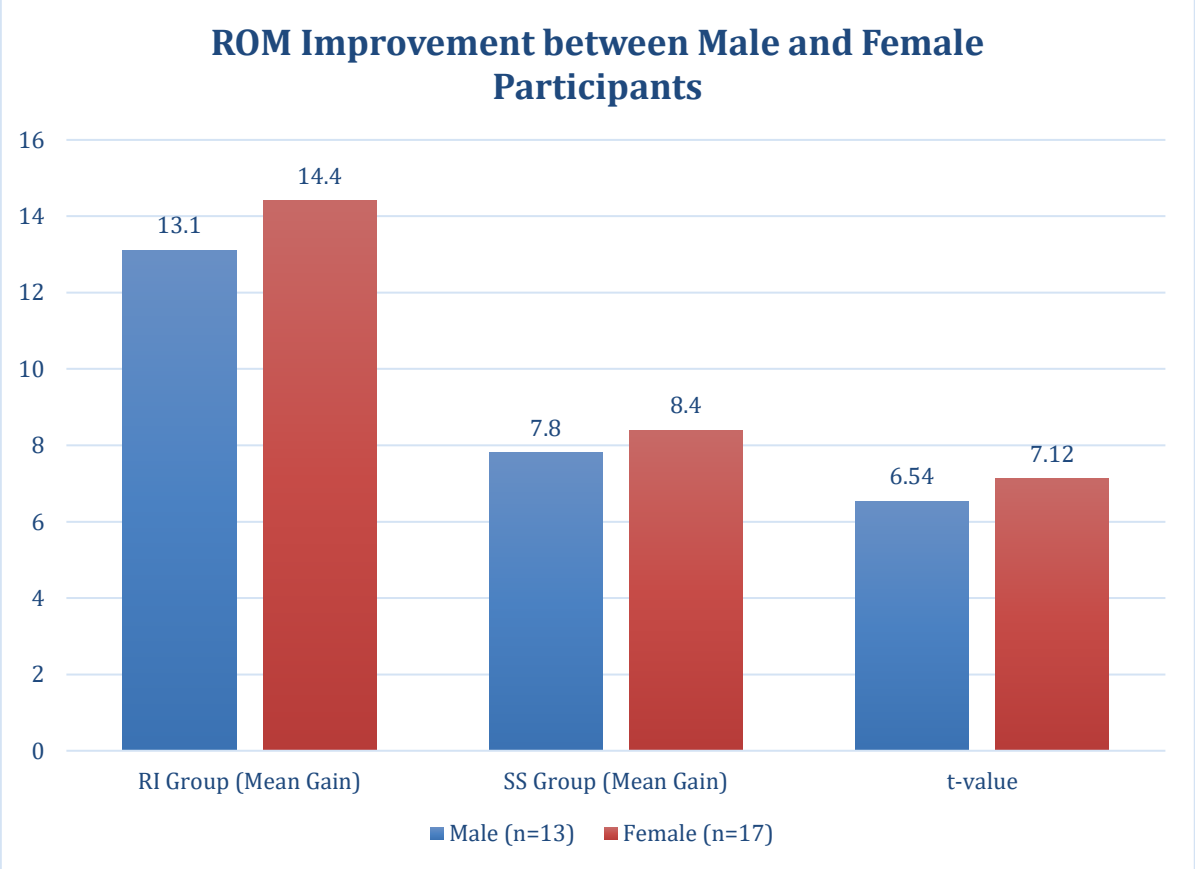

Figure 7. Mean hip extension ROM improvement among male and female participants

Table 7. Effect-size analysis (Cohen's d)

Comparison	Cohen's d	Effect-size strength
Group A (RI): pre vs post	4.49	Very large
Group B (SS): pre vs post	2.69	Large
Group A vs Group B: gain	2.58	Large

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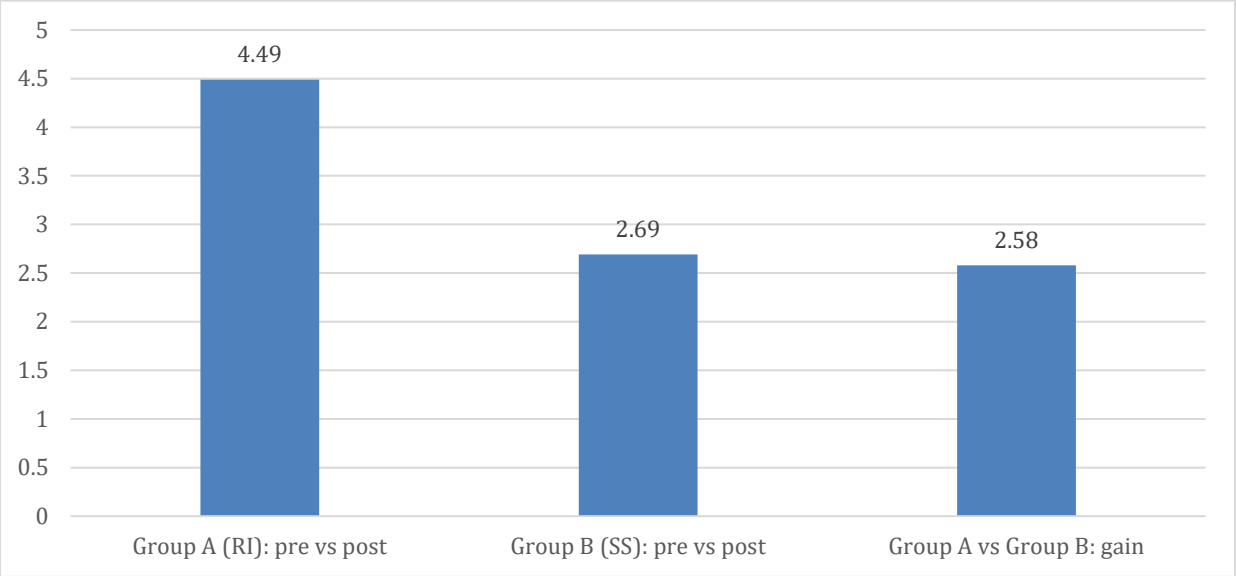

Figure 8. Cohen's d effect sizes for within-group and between-group ROM change

5. Discussion

The principal finding of this study was that both Reciprocal Inhibition and Static Stretching significantly increased hip extension ROM in individuals with iliopsoas tightness, but RI produced a substantially greater magnitude of change. Over two weeks, the RI group gained 13.82° compared with 8.15° in the SS group, creating a between-group difference of 5.67°. This difference was statistically significant and accompanied by a large between-group effect size (d=2.58). The findings therefore support the thesis alternative hypothesis that the two interventions do not produce equivalent outcomes.

The superiority of RI is consistent with the neurophysiological mechanism described in the thesis. During the RI technique, a submaximal isometric contraction of the hip extensors activates the antagonist muscle group and is intended to facilitate inhibition of the iliopsoas through spinal Ia inhibitory pathways. Once the contraction ends, reduced neural drive to the shortened muscle may allow the therapist to move the hip farther into extension before a new restrictive barrier is reached. This active contraction-relaxation strategy differs from SS, in which flexibility gain is achieved mainly through sustained passive loading, stress relaxation, and increased stretch tolerance [2,10,11].

The RI finding is also consistent with studies summarized in the literature review that report meaningful flexibility gains with PNF- and muscle-energy-based approaches. Nandala et al. used a closely related two-week framework for iliopsoas tightness and demonstrated significant improvement with RI [1]. The thesis also cites work in which PNF or contraction-relaxation techniques were more effective than conventional stretching in selected populations. At the same time, earlier literature has not always shown a clear advantage of one method, emphasizing that muscle group, dose, baseline stiffness, and population characteristics influence the size of response.

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Static Stretching remained clinically effective in this study. The SS group improved by 8.15° and reached a mean post-treatment ROM of 180.30°, demonstrating that repeated passive stretching can improve hip flexor length when delivered consistently. This is compatible with the thesis literature describing static stretching as a valid treatment for reduced extensibility and as a practical intervention in low back pain and hip-flexor rehabilitation [5,8,9]. Its smaller gain relative to RI should therefore be interpreted as comparative inferiority in this protocol rather than lack of therapeutic value.

The Modified Thomas Test findings strengthen the ROM results. Although every participant began with a positive test, 93.3% of subjects receiving RI achieved a negative test after treatment compared with 46.7% in the SS group. This means the advantage of RI was not restricted to a numerical change on the goniometer; it was also reflected in a categorical clinical indicator of normalized iliopsoas length. The reliability of careful goniometric positioning and control of pelvic compensation is particularly important when interpreting these findings [6].

Lifestyle correlations provide an additional perspective. Baseline ROM was inversely related to BMI ($r=-0.684$) and even more strongly to daily sitting duration ($r=-0.742$). The master chart therefore supports the thesis premise that prolonged sitting is closely associated with adaptive iliopsoas shortening. A chronically flexed hip posture may encourage shortening and altered lumbopelvic mechanics, while higher body mass may add mechanical and activity-related factors that further limit available hip extension. These associations do not establish causation, but they identify relevant clinical factors when screening sedentary individuals [4,7].

The sex-based analysis showed that the superiority of RI was present in both male and female participants. Females showed slightly higher mean gains in each intervention group, but the overall pattern was consistent: RI produced greater improvement than SS. This suggests that the treatment effect observed in the study was not confined to one sex category. Because the sample was small, however, sex-specific conclusions should be interpreted cautiously.

From a clinical perspective, RI may offer particular value when rapid restoration of hip extension is a treatment priority. Activating the gluteal musculature while reducing iliopsoas restriction may also be attractive in patients with postural imbalance because it addresses the shortened muscle and its functional antagonist during the same intervention sequence. SS remains useful when a simple passive method is preferred or when active contraction is not appropriate. The study does not establish long-term superiority because outcomes were assessed only after two weeks, and the durability of the greater RI gain remains unknown.

6. Clinical Implications

- Both Reciprocal Inhibition and Static Stretching can be used to improve hip extension ROM in individuals with iliopsoas tightness.
- Reciprocal Inhibition may be preferred when a larger short-term flexibility gain is desired and the patient can perform a controlled submaximal hip-extensor contraction.
- The Modified Thomas Test and universal goniometry can be used together to monitor both angular change and clinical normalization of iliopsoas length.

- Assessment should include sedentary exposure and BMI because the thesis found strong inverse associations between these factors and baseline hip extension ROM.
- Intervention for iliopsoas tightness may be strengthened by addressing prolonged sitting and lumbopelvic movement habits in addition to performing stretching techniques.

7. Limitations

- The study evaluated short-term effects over only two weeks; long-term retention of flexibility gains was not determined.
- The sample was limited to 30 participants from a single geographical setting, restricting generalizability.
- Objective neurophysiological measures such as surface electromyography were not used to directly quantify changes in muscle activation.
- The thesis describes the sample as asymptomatic/sedentary individuals with iliopsoas tightness; effects in patients with severe structural pathology remain uncertain.

8. Future Scope

- Future studies should include longer follow-up periods, including reassessment at six months, to determine retention of treatment gains.
- Reciprocal Inhibition should be compared with other muscle-energy approaches such as Post-Isometric Relaxation under identical dosing conditions.
- Electromyography may help quantify changes in iliopsoas and gluteal activation and clarify the proposed reciprocal-inhibition mechanism.
- Future work should examine functional outcomes such as gait, pelvic control, lumbar posture, and work-related movement tolerance in addition to isolated ROM.

9. Conclusion

This randomized comparative study found that both Reciprocal Inhibition and Static Stretching significantly improved hip extension range of motion in individuals with iliopsoas tightness. Reciprocal Inhibition produced the larger improvement, increasing mean ROM by 13.82° compared with 8.15° after Static Stretching, with a significant 5.67° between-group difference and a large effect size. Clinical normalization on the Modified Thomas Test was also higher with RI (93.3% versus 46.7%). Baseline restriction was strongly associated with higher BMI and longer daily sitting duration. Within the short two-week study period, the findings support Reciprocal Inhibition as the more effective of the two tested techniques for restoring iliopsoas flexibility, while Static Stretching remains a beneficial alternative.

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