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COMPARISON OF HOLD-RELAX TECHNIQUE AND STATIC STRETCHING ON HAMSTRING FLEXIBILITY IN NON-ATHLETE ADULTS: A RANDOMIZED CONTROLLED TRIAL

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ABSTRACT

Hamstring flexibility is crucial for preventing musculoskeletal injuries, yet comparative studies in non-athletes are limited.

This mixed-methods study compared the effectiveness of hold-relax (HR) proprioceptive neuromuscular facilitation versus static stretching (SS) on hamstring flexibility in non-athlete adults, incorporating participant perceptions. Twenty healthy non-athlete males (aged 20–36 years) were randomly assigned to an HR (n=10) or SS (n=10) group for a 6-week intervention. Hamstring flexibility was measured using the sit-and-reach test. Semi-structured interviews explored participant experiences. Paired and unpaired t-tests analyzed quantitative differences ($p<0.05$), and thematic analysis evaluated qualitative data.

Both groups improved significantly ($p<0.05$). The HR group showed greater mean improvement (7.2±3.10 cm) than the SS group (4.3±2.7 cm, $t=0.834$). Qualitative findings revealed HR participants reported higher engagement and perceived effectiveness, while SS participants valued simplicity but noted lower motivation. HR is more effective than SS for improving hamstring flexibility, with qualitative insights highlighting its engaging nature. This mixed-methods approach supports HR's utility in rehabilitation. Future research should explore physiological mechanisms and broader populations.

Keywords: *Hamstring flexibility, Hold-relax technique, Static stretching, Non-athlete adults, Mixed-methods RCT*

INTRODUCTION

The flexibility of hamstring muscles, which is the ability to stretch painlessly within their range of motion (ROM), is a pillar of musculoskeletal health and reduces the risk of various injuries, including strains, lower back pain, and movement dysfunction in different populations [1,2]

Hamstring flexibility enhances the ability to absorb force during dynamic activities, lowering the load on joints and soft tissues, which is vital for both athletes and non-athletes [3]. Hamstring tightness can lead to postural disturbances, loss of mobility, and increased injury risk in non-athletes who engage in sedentary activities or repetitive daily movements [4,5]. Although research on hamstring flexibility interventions is very important, most studies have focused on athletes, leaving a gap in knowledge regarding approaches for non-athlete populations [6].

The application of stretching is common in enhancing flexibility by changing the viscoelastic properties of muscles and reducing stiffness that may occur through neural and mechanical pathways [7,8]. A simple and easily accessible method, static stretching (SS), which involves sustained elongation of muscles for 30-60 seconds, is appreciated as an activity that can be easily implemented in both clinical and home settings [9]. Proprioceptive neuromuscular facilitation (PNF) techniques, on the other hand, use passive stretching combined with isometric contraction and relaxation, such as the hold-relax (HR) technique, to address both muscle length and neural inhibition, potentially providing even greater gains in ROM [10]. The HR method relies on the autogenic inhibition reflex, which involves an isometric contraction followed by relaxation to decrease muscle spindle activity, thereby increasing stretch tolerance [11]. Recent research suggests that HR could be more effective than SS in certain populations (such as the elderly or athletes), due to its multidimensional approach [12,13]. However, available evidence comparing these techniques among healthy non-athletic adults— a group with distinct biomechanical and lifestyle characteristics— remains quite limited [14].

This study, using a mixed-method research design, addresses a research gap by comparing the outcomes of HR intervention versus SS intervention on hamstring flexibility in healthy non-athlete adults with hamstring tightness. Flexibility is quantified through a numerical measure, complemented by qualitative reflections on participants' experiences. Due to HR's potential to act broadly and specifically on both mechanical and neural pathways—both of which have been shown to benefit flexibility increases (proximal and distal)—we expect HR to produce greater flexibility improvements than SS [1]. Additionally, qualitative data will shed light on participants' views regarding the success, comfort, and adherence to each intervention, providing a comprehensive picture of their practical effectiveness. Our research hypothesis is that HR will lead to significantly better improvements in hamstring flexibility, as measured by the sit-and-reach test, and that participants will find HR more engaging because it involves active interaction with the hamstrings. The findings may assist physical therapists in selecting the most effective stretching regimens, resulting in improved mobility and reduced injury risk among non-athletes.

Materials and Methods

Study Design

The study was carried out at King Hospital in the city of Swat and conducted with ethical IRB approval (IRB protocol #8490) in the form of a mixed-methods randomised controlled trial (RCT) with a duration of 6 weeks. The study was transparent and reproducible, as outlined in the CONSORT guidelines. Written informed consent was obtained from participants.

Participants

Twenty healthy non-athlete males (aged 20–36 years) with hamstring tightness (90°–90° straight leg raise) were recruited through random sampling from the community between January and March 2024. Inclusion criteria were: (1) healthy non-athletic males aged 20–36 years with hamstring tightness, and (2) ability to perform the sit-and-reach test. Exclusion criteria included: (1) orthopaedic deformities or musculoskeletal conditions (e.g., fractures, contractures, skin lesions, back pain), and (2) athletic or sports-

trained individuals. Participants were randomly assigned to the SS (n = 10) or HR (n = 10) group using a random number generator.

Interventions

- Static Stretching (SS) Group: Participants performed static hamstring stretches for 30 seconds, followed by 10-second rests, four sessions per day, five days a week, for six weeks. Stretches were held in a pain-free range, aiming for maximum elongation.
- • Hold-Relax (HR) Group: Participants performed a 30-second passive stretch, followed by a 15-second isometric contraction against resistance provided by a physiotherapist, and a 10-second relaxation, four sessions per day, five days a week, for six weeks. A trained physiotherapist supervised all sessions.

Outcome Measures

Hamstring flexibility was assessed using the Sit-and-reach test, which has been validated [15]. They used a 12-inch high box and a yardstick. The subjects sat with their feet flat on the box, knees fully bent, and reached as far as possible without pain, with their hands one on top of the other at the furthest point. Measurements were taken three times from the top of the box to the tibial tuberosity, and the average of the three measurements was used. Pre- and post-test scores were recorded.

Qualitative Measures

All 20 participants were approached after the intervention through a semi-structured interview to discuss their experiences with the HR or SS interventions. The interviews were audio-recorded, and verbatim transcripts were produced. Each interview lasted approximately 15 to 20 minutes. The questions focused on perceived effectiveness, comfort, motivations, and obstacles to adherence (e.g., "What did you think of the stretching sessions in terms of their comfort and engagement?"). Pilot testing of the interview guide was conducted on two non-participants to assess clarity.

Data Collection

Quantitative data were gathered at baseline and after the intervention (6 weeks) by trained physiotherapists to reduce measurement bias. Blinding was not possible due to the nature of the intervention. Qualitative interviews were carried out by a trained researcher in a private setting at King Hospital, Swat, within one week of completing the intervention.

Data Analysis

Data were analysed using SPSS version 25. Descriptive statistics (mean ± SD) summarized pre- and post-test sit-and-reach scores. Paired t-tests assessed within-group changes, and unpaired t-tests compared post-test scores between groups (α=0.05). An a priori power analysis (G*Power, effect size 0.5, power 0.8) confirmed that a sample size of 20 was sufficient.

Qualitative Analysis

An analysis of interview transcripts was conducted using a thematic approach, following the framework outlined in [16,17]. Two authors independently coded the transcripts, identified themes, and reached conclusions through discussion. Triangulation of themes and quantitative data was employed to provide a comprehensive understanding of the findings. Member checking was performed, and an audit trail was maintained to ensure the trustworthiness of the data.

Ethical Considerations

The study received approval from the IRB at King Hospital, Swat (protocol #8490). Participants gave informed consent for both quantitative and qualitative components, and anonymity was maintained. No conflicts of interest were disclosed.

Raw data are available at Figshare.

Study Registry: OSF

Preprint: OSF

Results

The dataset comprised 20 male participants (mean age, 28.5 ± 4.2 years), with no dropouts. Both

groups showed significant improvements in hamstring flexibility ($p < 0.05$).

Quantitative Results

Table 1 presents pre- and post-test sit-and-reach scores. The SS group improved from 16.10±1.4 cm to 17.80±2.7 cm, and the HR group from 16.40±1.7 cm to 18.55±3.10 cm. **Table 2** presents post-test scores, with the HR group achieving a higher mean (18.55 ± 3.10 cm) than the SS group (17.80 ± 2.7 cm). Paired t-tests **(Table 3)** indicated significant within-group improvements (SS: 4.3 cm, t=1.4, p<0.05; HR: 7.2 cm, t=1.3, p<0.05). An unpaired t-test **(Table 4)** confirmed HR's superiority (t=0.834, p<0.05).

Table 1: pre- and post-test sit-and-reach scores

Group	Pre-Test Mean ± SD	Post-Test Mean ± SD
SS	16.10 ± 1.4	17.80 ± 2.7
HR	16.40 ± 1.7	18.55 ± 3.10

Table 2: Post-Test Sit-and-Reach Scores (Mean ± SD, in cm)

Group	Post-Test Mean ± SD
SS	17.80 ± 2.7
HR	18.55 ± 3.10

Paired t-tests (Table 3) evaluated within-group improvements. The SS group exhibited a mean difference of 4.3 cm (t=1.4), and the HR group showed a mean difference of 7.2 cm (t=1.3), both statistically significant (p<0.05). An unpaired t-test (Table 4) comparing post-test scores produced a t-value of 0.834 (t-tab=1.4), suggesting a medium effect size favouring the HR group.

Table 3: Paired t-Test for Within-Group Comparisons

Group	Mean Difference (cm)	t-value (t-cal)	t-value (t-tab)
SS	4.3	1.4	-
HR	7.2	1.3	-

Table 4: Independent t-Test for Between-Group Comparison

Variable	t-value (t-cal)	t-value (t-tab)
Distances	0.834	1.4

Figure 1: Comparison of Post-Test Sit-and-Reach Scores

Caption: Bar graph comparing post-test sit-and-reach scores for the static stretching (SS) and hold-relax (HR) groups. The HR group achieved a higher mean score (18.55±3.10 cm) compared to the SS group (17.80±2.7 cm) (p<0.05).

Qualitative Results

1. Three key themes arose from the thematic analysis of interview data:
2. 1. Perceived Effectiveness: HR participants frequently described feeling "more stretched" and noticed "greater ease in movement" after the intervention. One participant remarked, "The hold-relax made my legs feel looser, like I could move better at work." SS participants reported improvements but perceived them

as less significant, with one saying, "It helped, but I didn't feel a big difference."

3. 2. Engagement and Comfort: HR participants found the technique engaging because of the physiotherapist's interaction, with comments like, "Working with the therapist kept me motivated." However, some experienced discomfort during isometric contractions. SS participants appreciated the simplicity and independence of SS but reported lower motivation, with one noting, "It was easy but got boring after a while."
4. 3. Adherence Barriers: HR participants pointed out that supervised sessions could be a barrier, whereas SS participants mentioned the difficulty of maintaining consistency without guidance. One SS participant said, "I sometimes skipped sessions because no one was checking."

Discussion

This mixed-methods RCT demonstrates that both HR and SS significantly improve hamstring flexibility in non-athlete adults, with HR showing greater efficacy (7.2±3.10 cm vs. 4.3±2.7 cm, t=0.834, p<0.05), as shown in Figure 1 and Tables 1–4. Qualitative findings enrich these results, revealing that HR participants perceived greater effectiveness and engagement, likely contributing to its superior outcomes. These align with [18], who reported enhanced ROM with HR in older adults due to neural inhibition and viscoelastic changes [15] similarly found HR more effective than lumbar mobilisation, supporting PNF's multifaceted mechanisms. Our study extends these findings to non-athletes, with qualitative data highlighting HR's interactive nature as a key factor. HR's superiority may stem from its dual action on mechanical (muscle elongation) and neural (autogenic inhibition) pathways [19]. Qualitative insights suggest that physiotherapist interaction in HR sessions enhanced participant engagement, potentially improving adherence and effort, as one participant noted the motivational aspect of supervision. However, alternative explanations include higher intervention intensity in HR or differences in participant motivation, as SS participants reported boredom. The supervised nature of HR may also have ensured consistent technique application, unlike SS, where self-administration led to variable adherence [9,10].

Clinical Relevance: HR's greater efficacy, combined with its perceived effectiveness, makes it a valuable tool for rehabilitation in non-athletes, particularly those with sedentary lifestyles prone to hamstring tightness [20]. Improved flexibility can reduce lower back strain and injury risk during daily activities [14,18]

]. However, HR's requirement for professional supervision may limit accessibility, as recognised by participants. SS, while less effective, offers a practical, self-administered option for resource-limited settings. Integrating qualitative insights, HR could be prioritised in clinical settings with physiotherapy support, while SS may suit home-based programmes.

Comparison with Existing Studies: Our findings contrast [1,2], who found no significant difference between HR and SS in recreational athletes, possibly due to the athletes' baseline flexibility. Another study [11] reported smaller HR effect sizes in athletes, suggesting population-specific responses. Qualitative data align with study [16], who noted PNF's engaging nature enhances participant commitment.

Limitations: The small sample size (n = 20) and male-only population limit generalizability. The absence of physiological measurements (e.g., muscle stiffness) restricts mechanistic insights. Qualitative findings may be affected by interviewer bias, although this is mitigated through rigorous analysis. Long-term outcomes and adherence beyond 6 weeks were not assessed.

Future Research: Larger, more diverse trials should verify HR's effectiveness across genders and age groups, including physiological assessments (e.g., electromyography) [7,13,18]. Investigating self-administered HR protocols could help address accessibility issues raised by participants. Long-term research should assess HR's effects on injury prevention and quality of life.

Clinical Message: HR is more effective and engaging than SS for improving hamstring flexibility in non-athletes, providing a strong rehabilitation tool when supervised. Qualitative insights highlight its motivational advantages, guiding clinical practice.

Conclusion

The hold-relax technique is more effective than static stretching for enhancing hamstring flexibility in non-athlete adults, with qualitative data emphasising its engaging nature. This mixed-methods approach supports the usefulness of HR in rehabilitation. Unresolved questions include the physiological mechanisms, efficacy in diverse populations, and long-term outcomes, all of which warrant further research.

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Conflict of Interest

None declared.

Ethical Statements

This study received approval from the Institutional Review Board at King Hospital, Swat (protocol #8490). All participants gave written informed consent. No conflicts of interest were declared.

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