

Comparative Effect of Static and Dynamic Stretching Exercises on Hamstring Flexibility in Football Players: A Comparative Study

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Abstract

Background

Hamstring flexibility is an important component of physical fitness in football players because football involves repeated sprinting, acceleration, deceleration, kicking, jumping and rapid changes in direction. Hamstring injuries represent a substantial proportion of injuries sustained by football players, making appropriate flexibility and conditioning strategies clinically relevant. Static and dynamic stretching are commonly incorporated into athletic training, although their comparative effects on hamstring flexibility remain debated.

Objective

To compare the effects of static and dynamic stretching exercises on hamstring flexibility in male football players over a four-week intervention period.

Methods

A pretest–posttest experimental comparative study was conducted among 40 male football players aged 18–25 years. Participants were randomly allocated into two groups of 20 participants each. Group A performed static hamstring stretching, while Group B performed dynamic stretching exercises. Both interventions were administered for 10–15 minutes per session, five days per week for four weeks. Hamstring flexibility was assessed before and after intervention using the Sit and Reach Test (SRT) and Active Knee Extension Test (AKET). Within-group changes were analyzed using paired *t*-tests and between-group post-intervention differences using independent *t*-tests.

Results

Both groups demonstrated statistically significant improvements in hamstring flexibility. In Group A, SRT increased from 25.10 ± 3.20 cm to 28.75 ± 3.10 cm, while AKET increased from $145.50 \pm 4.40^\circ$ to $150.40 \pm 3.90^\circ$ ($p < 0.001$ for both). In Group B, SRT increased from 24.90 ± 3.00 cm to 30.60 ± 2.80 cm and AKET increased from $144.80 \pm 4.10^\circ$ to $152.70 \pm 3.70^\circ$ ($p < 0.001$ for both). Post-intervention between-group analysis demonstrated statistically significant differences for SRT ($p = 0.048$) and AKET ($p = 0.049$), with greater changes observed in the dynamic stretching group. The mean SRT improvement was 3.65 cm in Group A versus 5.70 cm in Group B, while mean AKET improvement was 4.90° versus 7.90° , respectively.

Conclusion

Both static and dynamic stretching significantly improved hamstring flexibility in male football players following four weeks of intervention. The observed between-group results indicated greater improvement following dynamic stretching. Further adequately powered studies incorporating functional performance and injury-related outcomes are warranted.

Keywords: hamstring flexibility; static stretching; dynamic stretching; football; soccer; Sit and Reach Test; Active Knee Extension Test; sports physiotherapy

Introduction

Football is a physically demanding sport characterized by repeated high-intensity activities including sprinting, acceleration, deceleration, jumping, kicking and rapid changes in direction. These activities place considerable mechanical demands on the posterior thigh musculature. Hamstring injuries are among the most frequently reported injuries in football. A systematic review involving more than 3,800 soccer players reported an incidence of acute hamstring injury ranging from 0.3 to 1.9 injuries per 1,000 exposure hours in men, with hamstring injuries accounting for approximately 5–15% of soccer-related injuries.¹ In professional men's football, long-term surveillance has also demonstrated an increasing proportion of injuries attributable to the hamstring muscle group.²

The hamstring muscle complex primarily consists of the biceps femoris, semitendinosus and semimembranosus. These muscles contribute substantially to hip extension and knee flexion and function eccentrically during high-speed running, particularly when the limb transitions through the terminal swing phase. Consequently, appropriate flexibility and neuromuscular control of the hamstrings are important components of athletic preparation.

Flexibility may be described as the capacity of a muscle or muscle group to permit movement around a joint through an available range of motion. Reduced hamstring extensibility may influence lower-limb movement patterns and can affect activities requiring substantial hip flexion and knee extension. Assessment of hamstring flexibility is therefore frequently incorporated into sports physiotherapy screening and rehabilitation.

Stretching is one of the most commonly used approaches for improving flexibility. Static stretching involves positioning a muscle at an elongated length and maintaining the position for a predetermined period. Dynamic

stretching, in contrast, involves controlled active movements through an available range of motion. Both approaches have been used extensively in athletic training.

Evidence regarding static stretching has evolved considerably. Earlier literature raised concerns regarding reductions in strength and explosive performance following prolonged static stretching immediately before activity.³ However, more recent evidence indicates that the magnitude of these effects is dependent on stretching duration and the specific performance task.⁴ Furthermore, contemporary evidence indicates that chronic static stretching can produce meaningful improvements in flexibility.⁵

Dynamic stretching has received considerable attention because it combines movement, range-of-motion training and neuromuscular activity. It is commonly incorporated into sports-specific warm-up routines. Earlier experimental studies have reported beneficial effects of dynamic stretching on movement-related performance, while other studies have found static stretching to be equally or more effective for certain measures of static flexibility.^{6,7}

Importantly, a recent systematic review and meta-analysis specifically examining dynamic and static stretching for hamstring flexibility included 27 randomized controlled trials involving 606 participants. The authors reported that the comparative effects differed according to the timing and duration of stretching, with no consistent superiority of one technique across all time points and outcomes.⁸ This variability provides a rationale for investigating stretching responses in specific athletic populations.

The assessment tools selected for the present study were the Sit and Reach Test and Active Knee Extension Test. The Sit and Reach Test is a practical field measure with moderate criterion-related validity for estimating hamstring extensibility.⁹ The Active Knee Extension Test is also widely used for assessing hamstring flexibility, and evidence supports its reliability in individuals with flexibility deficits.¹⁰

Although previous research has investigated different stretching approaches, relatively limited evidence is available regarding their comparative effects when applied as a structured four-week program specifically to young male football players. Therefore, the present study compared static and dynamic stretching interventions for improving hamstring flexibility in football players.

Aim

To compare the effects of static and dynamic stretching exercises on hamstring flexibility in male football players.

Objectives

1. To assess baseline hamstring flexibility in male football players.
2. To determine the effect of a four-week static stretching program on hamstring flexibility.
3. To determine the effect of a four-week dynamic stretching program on hamstring flexibility.
4. To compare post-intervention flexibility outcomes between static and dynamic stretching groups.

Hypotheses

Null hypothesis (H_0):

There is no statistically significant difference in improvement in hamstring flexibility between football players receiving static stretching and those receiving dynamic stretching after four weeks.

Alternative hypothesis (H_1):

There is a statistically significant difference in improvement in hamstring flexibility between football players receiving static stretching and those receiving dynamic stretching after four weeks.

Materials and Methods

Study Design

A two-group pretest–posttest experimental comparative design was used.

- **Group A:** Static stretching
- **Group B:** Dynamic stretching

Participants

Forty male football players aged 18–25 years participated in the study. Participants were recruited from local football academies and clubs.

The source study specifies that participants had been participating in regular football training and met the predefined eligibility criteria.

Sample Size

A total of 40 participants were included:

- Group A: $n = 20$
- Group B: $n = 20$

The supplied study reports that sample size was determined based on a pilot study and review of comparable literature.

Eligibility Criteria

Inclusion criteria

- Male football players aged 18–25 years.

- Minimum six months of regular football training.
- Regular football participation.
- No lower-limb injury during the preceding three months.
- Willingness to participate.
- Written informed consent.

Exclusion criteria

Participants were excluded if they had:

- Current hamstring strain.
- Recent lower-limb surgery.
- Musculoskeletal disorders affecting participation.
- Neurological or systemic disorders affecting exercise participation.
- Any contraindication to stretching or physical exercise.

Randomization

After baseline assessment, participants were randomly allocated into Group A or Group B using computer-generated random numbers. Allocation was concealed using opaque sealed envelopes opened following baseline assessment.

Outcome Measures

Sit and Reach Test

Participants sat on the floor with the legs extended and feet positioned against the measurement apparatus. They were instructed to reach forward using both hands while maintaining the prescribed position. Three trials were performed and the best score was recorded.

The Sit and Reach Test has demonstrated acceptable reproducibility and moderate criterion-related validity for estimating hamstring extensibility.⁹

Active Knee Extension Test

Participants were positioned supine with the tested hip flexed to approximately 90°. The participant actively extended the knee as far as possible while maintaining the hip position. The knee angle was measured using a universal goniometer.

The Active Knee Extension Test is a commonly used clinical assessment of hamstring flexibility and has demonstrated good reliability.¹⁰

Intervention Protocol

Both interventions were performed for **four weeks, five days per week**, with sessions lasting approximately **10–15 minutes**.

Participants were instructed not to undertake additional lower-limb flexibility training during the study period.

Group A: Static Stretching

Participants performed bilateral hamstring static stretching.

Each stretch was:

- Held for 30 seconds.
- Repeated three times per leg.
- Separated by approximately 15 seconds of rest.
- Performed to the point of mild discomfort without pain.
- Conducted five days per week for four weeks.

The exercises included:

1. Seated hamstring stretch.
2. Supine hamstring stretch using a resistance band.

Group B: Dynamic Stretching

Participants first completed a five-minute general warm-up consisting of light jogging.

The dynamic stretching program consisted of controlled active movements performed bilaterally, including:

1. Straight-leg marching/kicks.
2. Walking toe touches.
3. Dynamic lunge with forward reach.

Each movement was performed for approximately 10 repetitions per limb or over a prescribed 20-metre distance, depending on the exercise.

The movements were performed progressively and in a controlled manner rather than as uncontrolled ballistic movements.

Statistical Analysis

Statistical analysis was performed using **SPSS version 25.0**.

Descriptive statistics were used to summarize participant characteristics and outcome variables. The Shapiro–Wilk test was used to assess distributional normality. According to the supplied analysis, the outcome variables demonstrated a normal distribution ($p > 0.05$).

Within-group pre- and post-intervention differences were analyzed using the paired t -test. Between-group post-intervention differences were analyzed using the independent t -test.

Statistical significance was established at $p < 0.05$.

Statistical reporting note

For a final Scopus submission, I recommend additionally reporting **95% confidence intervals and effect sizes (Cohen's d)**, and preferably analyzing the between-group intervention effect using **ANCOVA adjusted for baseline values** or an analysis of change scores. This would strengthen the statistical methodology beyond the original thesis analysis.

Results

Participant Characteristics

Both groups consisted exclusively of male football players.

Variable	Group A	Group B
Sample size	20	20
Male	20 (100%)	20 (100%)
Female	0 (0%)	0 (0%)
Mean age, years	21.35 $\pm$ 1.88	21.10 $\pm$ 1.92

The groups demonstrated similar mean ages at baseline.

Effect of Static Stretching

Table 1. Pre- and post-intervention SRT and AKET values in Group A

Outcome	Pre-test Mean $\pm$ SD	Post-test Mean $\pm$ SD	Mean Difference	t	p
SRT (cm)	25.10 $\pm$ 3.20	28.75 $\pm$ 3.10	3.65	8.52	<0.001
AKET (°)	145.50 $\pm$ 4.40	150.40 $\pm$ 3.90	4.90	7.68	<0.001

Static stretching produced statistically significant improvements in both outcome measures. SRT increased by **3.65 cm**, while AKET increased by **4.90°**.

Effect of Dynamic Stretching

Table 2. Pre- and post-intervention SRT and AKET values in Group B

Outcome	Pre-test Mean $\pm$ SD	Post-test Mean $\pm$ SD	Mean Difference	<i>t</i>	<i>p</i>
SRT (cm)	24.90 $\pm$ 3.00	30.60 $\pm$ 2.80	5.70	11.35	<0.001
AKET (°)	144.80 $\pm$ 4.10	152.70 $\pm$ 3.70	7.90	10.22	<0.001

Dynamic stretching produced statistically significant improvements in both outcome measures. SRT increased by **5.70 cm**, whereas AKET increased by **7.90°**.

Between-Group Comparison

Table 3. Post-intervention comparison between static and dynamic stretching groups

Outcome	Static Group Mean $\pm$ SD	Dynamic Group Mean $\pm$ SD	Mean Difference	<i>t</i>	<i>p</i>
SRT (cm)	28.75 $\pm$ 3.10	30.60 $\pm$ 2.80	1.85	2.03	0.048
AKET (°)	150.40 $\pm$ 3.90	152.70 $\pm$ 3.70	2.30	2.01	0.049

The post-intervention comparison demonstrated statistically significant differences between the groups for both SRT and AKET. The dynamic stretching group demonstrated higher post-intervention values.

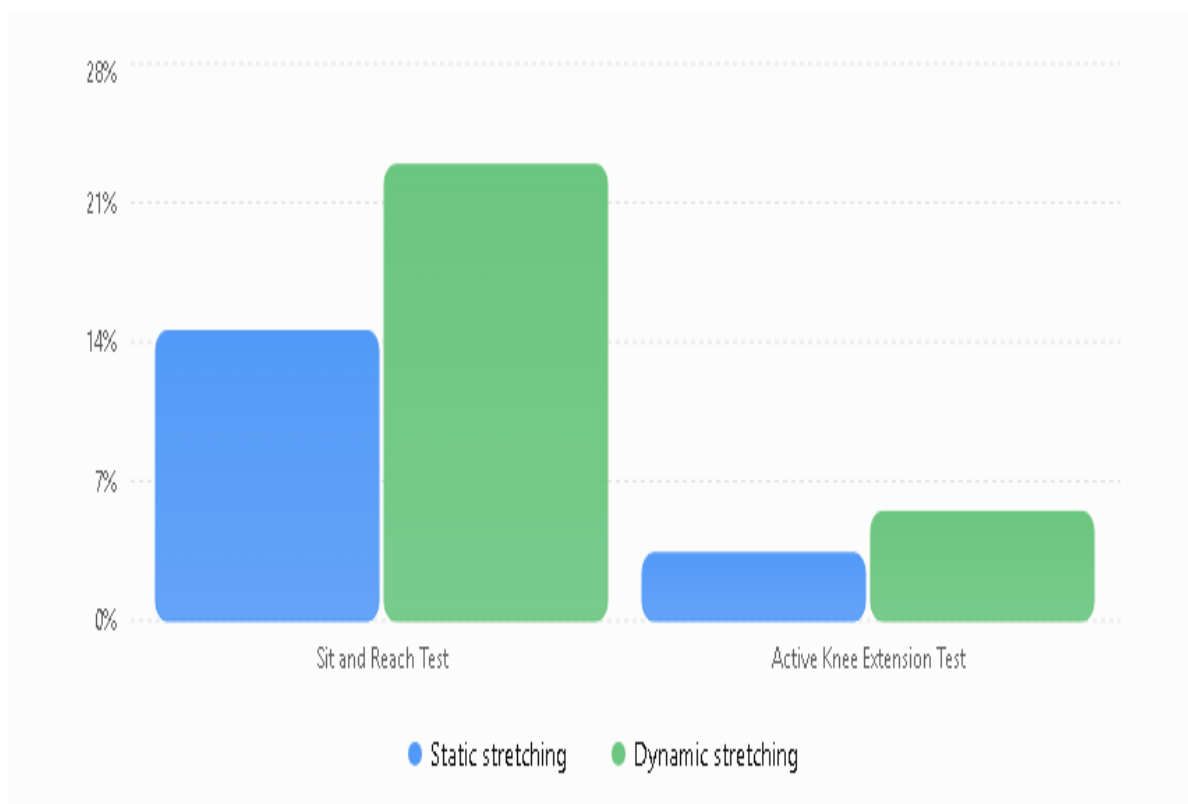
Magnitude of change

Outcome	Static stretching	Dynamic stretching	Difference in mean improvement
SRT	+3.65 cm	+5.70 cm	2.05 cm
AKET	+4.90°	+7.90°	3.00°

The supplied data therefore show a larger absolute pre–post improvement in the dynamic stretching group for both outcomes.

Graph 1: Comparison of Improvement in Hamstring Flexibility

Percentage improvement from pre-test to post-test after 4 weeks of static versus dynamic stretching.



Discussion

The present study compared the effects of static and dynamic stretching exercises on hamstring flexibility in male football players aged 18–25 years. The principal finding was that **both interventions produced significant improvements in hamstring flexibility after four weeks**, while the observed changes were greater in the dynamic stretching group.

The improvement observed following static stretching is consistent with contemporary evidence demonstrating that repeated static stretching can improve flexibility. A recent systematic review and meta-analysis involving 189 studies and 6,654 adults reported a large positive effect of chronic static stretching on flexibility.⁵ The authors also observed that hamstring flexibility may respond particularly well to static stretching.

The mechanisms underlying improvements following static stretching are likely multifactorial. Current evidence suggests that chronic static stretching is associated with reductions in overall muscle stiffness and increases in stretch tolerance.¹¹ These adaptations may contribute to increased available range of motion without necessarily requiring structural elongation of the muscle fascicles.

In the present study, the static stretching group demonstrated a mean improvement of **3.65 cm in SRT** and **4.90° in AKET**, with both changes statistically significant ($p < 0.001$). These findings support the use of static stretching as an effective intervention for improving hamstring flexibility.

The dynamic stretching group also demonstrated statistically significant improvement. SRT increased by **5.70 cm**, and AKET increased by **7.90°**. The greater observed improvement may relate to the active nature of dynamic stretching, which repeatedly moves the joint through an available range of motion while simultaneously engaging neuromuscular control.

However, the interpretation that dynamic stretching is universally superior should be made cautiously. A systematic review and meta-analysis of 27 randomized trials found that the comparative effects of static and dynamic stretching on hamstring range of motion varied according to intervention timing and duration.⁸ Thus, differences between the present findings and previous studies may be related to participant characteristics, stretching dose, exercise selection, measurement method and training status.

The present study found statistically significant post-intervention differences between groups for both SRT ($p = 0.048$) and AKET ($p = 0.049$). The mean improvements also favored dynamic stretching. Nevertheless, because the between-group analysis in the supplied study compares post-intervention values rather than directly modeling baseline-adjusted change, these findings should be interpreted as evidence of a post-intervention difference rather than definitive proof of superiority.

The choice of flexibility assessment is also important. The Sit and Reach Test is convenient for field-based assessment and has moderate criterion-related validity for hamstring extensibility.⁹ However, it can also be influenced by lumbar and anthropometric factors. Therefore, combining SRT with an angular measure such as AKET, as performed in the present study, provides complementary information regarding flexibility.

The clinical relevance of the findings is particularly important in football. Hamstring injuries remain a substantial burden in football, and surveillance studies have demonstrated considerable injury incidence and recurrence.^{1,2} Although improved flexibility cannot by itself be interpreted as proof of reduced injury incidence, maintaining adequate range of motion is one component of a broader injury-prevention and physical-conditioning strategy.

Earlier literature has often emphasized concerns regarding static stretching immediately before explosive activities.^{3,4} However, recent evidence suggests that short-duration static stretching may have minimal effects on subsequent athletic performance when incorporated appropriately into a complete warm-up.¹² Therefore, the present findings should not be interpreted as establishing that static stretching should be excluded from football training. Instead, the results demonstrate that both methods can improve hamstring flexibility, with greater observed flexibility gains following the dynamic protocol used in this study.

Clinical Implications

The findings have potential relevance for sports physiotherapists, strength and conditioning professionals and football coaches.

A structured four-week stretching program was associated with improved hamstring flexibility using both SRT and AKET. Dynamic stretching produced greater observed changes in the present sample and may therefore be incorporated into active warm-up and movement-preparation programs.

Static stretching may remain useful when the primary objective is flexibility development, particularly when performed as a dedicated flexibility session rather than immediately before high-intensity explosive activity.

The selection of stretching technique should therefore consider:

- the objective of the session;
- timing relative to football training;
- required range of motion;
- athlete characteristics;
- injury history; and
- overall conditioning program.

Limitations

Several limitations should be considered.

First, the sample consisted of only 40 participants, limiting statistical power and generalizability. Second, all participants were young male football players; therefore, the findings cannot automatically be extrapolated to female football players, older athletes or other sporting populations.

Third, the intervention lasted only four weeks, and no long-term follow-up was undertaken. Consequently, the persistence of the observed flexibility improvements remains unknown.

Fourth, the study assessed flexibility but did not measure sprint speed, agility, jumping performance, kicking performance or actual hamstring injury incidence. Therefore, the relationship between increased flexibility and athletic performance or injury prevention cannot be established from these results.

Fifth, manual goniometry used for AKET assessment can be affected by measurement variability. The supplied study also identified possible effects of uncontrolled factors such as sleep, hydration, diet and other physical activity.

Finally, although randomization was reported, the manuscript would be strengthened by reporting the exact randomization procedure, allocation sequence generation, participant flow, adherence rates and any dropouts.

Future Research

Future investigations should:

1. Recruit larger samples from multiple football academies and clubs.
2. Include female football players.
3. Include longer intervention and follow-up periods.
4. Measure sprint speed, agility, jumping and kicking performance.
5. Record hamstring injury incidence prospectively.
6. Compare static and dynamic stretching with PNF and other flexibility interventions.
7. Examine dose-response relationships.
8. Include objective measures of muscle stiffness and neuromuscular function.
9. Use baseline-adjusted statistical models such as ANCOVA.
10. Investigate whether flexibility improvements are maintained following cessation of training.

Conclusion

Both static and dynamic stretching exercises produced statistically significant improvements in hamstring flexibility among male football players following a four-week intervention. Static stretching increased SRT by 3.65 cm and AKET by 4.90°, whereas dynamic stretching increased SRT by 5.70 cm and AKET by 7.90°. The between-group analysis showed statistically significant post-intervention differences for both SRT and AKET, with greater observed improvements in the dynamic stretching group.

The findings support the use of structured stretching programs to improve hamstring flexibility in football players. However, the results should be interpreted within the limitations of the sample size, four-week duration and flexibility-focused outcomes. Further larger and methodologically rigorous studies incorporating athletic performance and injury outcomes are required.

Declarations

Informed Consent

Written informed consent was obtained from participants according to the study protocol. **The exact documentation should be verified before submission.**

Funding

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Conflict of Interest

No Conflict of Interest.

Author Contributions

- **Dr. Namrata Srivastava:** Conceptualization, study supervision, methodology, interpretation and manuscript preparation.
- **Dr. Gunjan Shukla:** Methodology, participant assessment, data interpretation and manuscript review.
- **Dr. Kalpana Jain:** Methodological review, data interpretation and critical revision.
- **Dr. Kartik Chhonker:** Statistical analysis, manuscript preparation, literature review and critical revision.
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