Efficacy of Combined Iliopsoas Release Techniques and Core- strengthening on Agility, Balance, Running Speed, and Pain Perception among Female Runners

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Abstract

In athletes, hip pain and restricted motion are common issues that can affect performance. The iliopsoas muscle, as the primary hip flexor, plays a crucial role in maintaining the integrity and strength of the hip joint. Tightness in the iliopsoas muscle often results from overuse or strain during activities like running. Concurrently, core muscle weakness or dysfunction undermines running biomechanics, potentially leading to injuries in the lumbar spine, pelvis, and lower extremities. Addressing these factors through targeted interventions, such as iliopsoas release techniques and core strengthening exercises, is essential for optimizing performance and mitigating injury risks in athletic populations. The study aimed to determine the effects of combined iliopsoas release techniques and core-strengthening exercises on agility, balance, running speed, and pain perception among female runners. A one-group pretest-posttest experimental design with 30 female runners (aged 18-30) recruited from Guru Dronacharya Sports Academy, Gurugram, Haryana, using simple and convenient sampling. Outcome variables included a Visual Analogue Scale for pain, a modified Star Excursion Balance Test for dynamic balance, a t-test for agility, and a 50-meter dash test for running speed. The intervention comprised four weeks of core strength training combined with iliopsoas release. Data analysis using repeated measures ANOVA across three-time points (baseline, 2 weeks, and 4 weeks) revealed significant reductions in VAS scores (both Rest and Activity) from baseline to post-intervention assessments at 2 weeks and 4 weeks, indicating substantial effectiveness of the intervention. Significant improvements were also observed in the T-test mSEBT, and 50 Meter Dash Test, among female runners with anterior hip pain. This study concluded that iliopsoas muscle release combined with core-strength training proves beneficial for enhancing agility, dynamic balance, and speed, and reducing pain among female runners experiencing anterior hip pain.

Keywords: *Core-strengthening, Agility, Dynamic balance, modified Star Excursion Balance Test, Visual Analog Scale, Pain intensity, 50-meter dash test, Running speed.*

Introduction

Running is a highly beneficial exercise for individuals aiming to attain physical fitness and lead a healthy lifestyle, associated with longevity and reduced cardiovascular disease risk factors. It encompasses both anaerobic and aerobic elements, requiring intricate coordination and engaging the entire body [1]. Although running offers numerous health benefits, musculoskeletal injuries related to running are widespread. Studies report that the occurrence and frequency of injuries among runners vary significantly, with rates ranging from 3.2% to 84.9% [2]. Muscle strength, flexibility, agility, endurance, coordination, balance, and movement efficiency are crucial for effective performance in sports-related skills [3]. Running primarily engages the lower extremities, and inadequate strength in the muscles stabilizing the pelvis and trunk can heighten instability in the body's center of gravity, increasing the risk of injuries [4].

During the running cycle, the lumbo-pelvic-hip complex undergoes distinct motions across its phases. A complete cycle includes stance and swing phases, each with specific subdivisions: propulsion and absorption in the stance, and initial and terminal swing in the swing phase. These phases roughly constitute 40% and 60% of the entire running cycle, respectively. Support for the lumbo-pelvic region during running is provided by critical stabilizing mechanisms within the core. These include the thoracolumbar fascia, intra-abdominal pressure, as well as muscles such as the paraspinals (interspinales and intertransversarii) and deep lumbar musculature (multifidus, lower longissimus, and iliocostalis) [5].

Weakness or dysfunction in core muscles can impair the efficiency of the running cycle and potentially raise the chances of injuries to the lumbar spine, pelvis, and lower extremities. Inadequate stability in the lumbo-pelvic region during running has been identified as a factor contributing to lower back pain among athletes [6]. Core muscle function is hypothesized to decrease excessive limb movement during exercise by activating the central core. This activation enhances the effectiveness of movements in the arms and legs by providing greater stability and precision in the extremities. Additionally, improved balance from strengthened core muscles stabilizes individual joints, enabling multi-joint muscles to operate more efficiently and better control spinal movements [7]. Another study suggests that weaknesses or poor coordination in core muscles disrupt the efficient transfer of energy, potentially reducing movement effectiveness and further contributing to injury through strain and overuse [8].

Core strength training (CST) has gained popularity in athletic training programs for its aim to enhance muscular strength and power in athletes [8]. When running, all abdominal muscles contract synergistically, generating tension across the rectus sheet in the abdomen. This tension, combined with movement of the viscera and diaphragm, increases intra-abdominal pressure, which actively supports the body during running alongside the activation of the transversus abdominis muscle [9]. Its primary goal is to stabilize the spine and pelvis, thereby improving the efficient transfer of energy from the larger muscles of the torso to the smaller muscles of the extremities during sports activities [8].

Core training emphasizes strengthening and enhancing power in both local and global muscle groups that collaborate to stabilize the spine. Global muscles, such as the rectus abdominis, obliques, latissimus dorsi, and erector spinae, work externally, while local muscle groups like the transverse abdominis, multifidus, and pelvic floor muscles operate deeper within the body [10]. Core muscles play a crucial role in optimizing balance and enhancing athletic performance during movements involving the lower extremities [11]. It is hypothesized that a well-developed core can facilitate the efficient transfer of force from the lower body to the upper body, optimizing energy expenditure in the process [12]. Experts widely regard core strength training as a pivotal element in power and conditioning programs, crucial for enhancing athletic performance and mitigating injury risks. This training method is extensively applied across strength training, health, fitness, and rehabilitation sectors [13].

Clinically, muscle tightness is recognized as a primary factor in running injuries. Approximately 92% of injured runners display one or two muscle imbalances that could potentially contribute to their running-related injuries [14]. The iliopsoas muscle plays a key role in hip joint movement and stabilization during activities such as walking, running, and standing up from a seated position. It is active during the swing phase for 30-60% of the running cycle. Tightness in the iliopsoas muscle can limit hip joint flexion, resulting in decreased running speed. Among all the muscles involved, the iliopsoas muscle has the most significant impact on running speed [15].

Methodology

Participants

A one-group pretest-posttest experimental study design was used for the study. Thirty participants were recruited from Guru Dronacharya Sports Academy in Gurugram, Haryana. The sampling method used was simple and convenient. The research was single-blinded, where participants were unaware of the intervention while the therapist was aware. Sample size calculation was performed using G* power software.

Ethical approval

The research received ethical approval from the institutional review board of the H.N.B Uttarakhand Medical Education University. It followed the National Ethical Guidelines for Biomedical & Health Research involving Human Participants issued by the Indian Council of Medical Research (2017) and adhered to the Helsinki Declaration (2013).

Selection Criteria

Participants included in the study were female athletes aged between 18 to 30 years, who had at least one year of experience running distances of 200, 300, 500, and 700 meters as part of the campus athletic team. They also experienced anterior hip pain during activity and tested positive on the modified Thomas test. Participants were excluded from the study if they had a history of (a) trauma, (b) injuries to the hip, knee, ankle, or lower back, (c) recurrent ankle sprains, (d) hernia, (e) surgery on the hip, knee, or ankle, and/or (f) vestibular dysfunction [7].

Procedure

Participants were selected based on specific criteria for inclusion and exclusion. Before enrolment, all participants were thoroughly briefed on the study procedures and potential advantages. They were instructed to abstain from vigorous activities within 24 hours before measurements. Additionally, they were advised to avoid caffeine and consume a light meal 2 to 3 hours before assessments. Written consent forms were provided to all participants, each agreeing to participate for four weeks. Following consent, subjective and objective evaluations were conducted on each participant before any interventions commenced. Initially, all participants underwent evaluations for outcome variables in a specific sequence: Visual Analogue Scale (for pain intensity), modified Star Excursion Test (for dynamic balance), T-test (for agility), and 50-yard dash test (for running speed). Between each test, participants were allowed one minute of rest. Following the baseline data collection, participants underwent combined release of the iliopsoas muscle and core-strength training. Outcome measures were assessed initially at baseline, then at two weeks, and subsequently at four weeks after the intervention.

Equipment used: Cone markers, stopwatch, couch, measuring tape, micropore tape, marker, Physioball, flat and clear surface of at least 70 meters, pen, and paper.

Outcome Variables

VAS (Visual Analogue Scale)

The visual Analogue Scale (VAS) was employed to assess the intensity of pain experienced by female runners at rest and during physical activity. Participants were provided with a 100 mm horizontal line labeled 'no pain' at one end and 'worst pain imaginable' at the other, with intermediate descriptors ('slight,' 'moderate,' 'severe') evenly distributed along the line [16]. Before administering the VAS, participants received verbal and written instructions explaining how to use the scale. They were informed that they would mark a point on the line corresponding to their current pain level, with 'no pain' representing 0 mm and 'worst pain imaginable' representing 100 mm. Participants were asked to rate their pain intensity on the VAS twice: once during a period of rest and once immediately after engaging in physical activity (e.g., running). For consistency, the same researcher administered the VAS to all participants. The marked points on the VAS were measured in millimeters from the 'no pain' end to the participant's mark. These measurements were recorded and used for quantitative analysis to evaluate changes in pain intensity between rest and activity [17].

T-Test

The T-Test was used to assess the agility of the participants, where participants started behind point A and, upon the timer's command, sprinted 9.14 meters to cone B, touching it with their right hand. They then shuffled left 4.57 meters to cone C, touching it with their left hand, followed by a shuffle right to cone D (9.14 meters), touched with their right hand. Next, they shuffled back left to cone B (4.57 meters), touching it with their left hand before running backward to cone A. Timing was recorded to the nearest 0.1 second using a stopwatch. If the participant crossed feet during shuffling, missed touching cones, or failed to face forward, the trial was repeated. The fastest trial was selected for statistical analysis [7].

mSEBT (Modified Star Excursion Balance Test)

Before conducting the Modified Star Excursion Balance Test (mSEBT), the length of the participant's lower limb was measured. This measurement was taken while the participant lay supine, with one end of a measuring tape placed at the Anterior Superior Iliac Spine (ASIS) and the other end at the most distal part of the medial malleolus. Following this, a grid was created on the floor using adhesive micropore tape and a universal goniometer. The grid consisted of three lines: two posterior lines intersecting at a 90° angle from the center of the grid and angled at 135° from an anterior line. The subject was positioned in the center of the grid and instructed to perform single-leg stances while reaching with the swing leg in three directions: anterior, postero-medial, and postero-lateral, with hands on hips, returning the swing leg to the starting position each time. The distance reached in each direction was measured [18]. Results were expressed as a percentage by dividing reach distances by leg length and multiplying by 100, providing a standardized measure of reach distance relative to leg length [19].

50 Meter Dash Test

The procedure involved conducting a single maximum sprint over a distance of 50 meters, with the time recorded for each attempt. A thorough warm-up was conducted, including practice starts and accelerations. Participants began from a stationary standing position with one foot positioned in front of the other, ensuring the front foot remained behind the starting line. When ready, the starter gave instructions to prepare ("ready") and then initiated the sprint ("go"). Guidance was provided by instructors on techniques to optimize speed, emphasizing staying low and maximizing arm and leg movement. Participants were encouraged to maintain maximum speed until they crossed the finish line. Each participant performed three sprint trials, and the best performance time was used for statistical analysis. The time taken to complete the 50-meter distance was measured in seconds [20].

Interventions

Core Strength Training

Core strength training was conducted three times per week over four consecutive weeks. The training program included a series of exercises aimed at progressively increasing the difficulty level to target the abdominal, low-back, and pelvic muscles. These exercises were selected based on previous descriptions by Ozmen and Aydogmus [11,7].

Table 1. Outline of the Core Strength Training.

Week	Program	Sets, Reps, Time
1	Abdominal bracing and hollowing	Hold 20 seconds/3 sets
	Supine Bridge	Hold 20 seconds/3 sets
	Prone Bridge	Hold 20 seconds/3 sets
2	Side bridge	Hold 20 seconds/3 sets
	Supine bridge exercise with alternate leg extension	20 repetitions/3 sets
	Seated marching on physio ball	20 repetitions/3 sets
3	Dead bug	20 repetitions/3 sets
	Supine bridge on physio ball	Hold 20 seconds/3 sets
	Prone bridge on physio ball	Hold 20 seconds/3 sets
4	Curl-up on physio ball	20 repetitions/3 sets
	Superman on physio ball	Hold 20 seconds/3 sets
	Physio ball lunge	20 repetitions/3 sets

Iliopsoas Release

Before initiating the procedure, it is essential to first palpate the iliopsoas muscle to accurately locate its position and assess its tension and sensitivity.

Palpation: Start by locating the bony prominence at the front of the pelvis, known as the ASIS. Move your fingers slightly inferiorly and laterally from the ASIS to locate the bony ridge of the iliac crest. This provides orientation for the position of the iliopsoas muscle. With the participant relaxed, apply gentle pressure just above the ASIS. The iliopsoas muscle lies deep beneath the abdominal muscles in this region. To further identify the iliopsoas muscle, instruct the participant to perform hip movements involving flexion, extension, and internal rotation. As they perform these movements, you can feel the muscles contracting and relaxing beneath your fingers [1].

Static Release: The participant was positioned lying on their back (supine) with the hip and knee flexed. The therapist instructed the participant to breathe in and out. During exhalation, the therapist applied deep pressure just above the Anterior Superior Iliac Spine (ASIS). The pressure was maintained while the therapist administered 10 oscillations over 10 minutes, with each oscillation lasting 10 seconds and including a 10-second hold between sets. This technique specifically targets the iliopsoas muscle, which runs from the lumbar spine to the inner thigh, aiding in its relaxation and release of tension [1].

Dynamic Release: The participant lay in a supine position and was instructed to breathe deeply. As the participant exhaled, the therapist applied deep pressure just above the Anterior Superior Iliac Spine (ASIS). Simultaneously, the participant performed hip movements involving flexion, extension, and internal rotation. Oscillations were administered during the phase of hip extension and internal rotation. Each session consisted of 10 oscillations lasting for 10 minutes, with a 10-second hold between sets. These techniques were aimed at targeting the iliopsoas muscle effectively for relaxation and tension release [1].

Participants were briefed on the four-week protocol, which consisted of two phases. Phase 1 spanned 2 weeks and exclusively utilized static release techniques. Phase 2 involved progressing from static release to dynamic release methods [1].

Statistical Analysis

All statistical analyses were performed using the Statistical Package for Social Sciences (SPSS) version 27. Descriptive Statistics (mean ± SD) were calculated for all variables. The Shapiro-Wilk test was employed to assess the normality of the data distribution. Upon confirming the normal distribution of the data, a repeated measure ANOVA was conducted to compare the pre- and post-intervention values within the group at baseline, 2 weeks, and 4 weeks. The significance level was set at $p < 0.05$ for all statistical analyses. Partial eta squared values were calculated to determine the effect sizes for the repeated measures ANOVA.

Results

The mean age of the participants was 23.5 years (SD = 3.47), indicating a young adult cohort. The average height was 170.8cm (SD = 8.05), and the mean weight was 66.4kg (SD = 7.32). The average Body Mass Index (BMI) was 22.7 kg/m2 (SD = 2.29), which falls within the normal weight range. Additionally, the mean leg length discrepancy (LLD) for the right leg was 89.3 cm (SD=8.18). These values indicate that the participants had relatively symmetrical leg lengths (Table 2).

Table 3 displays the within-group comparisons, for the pre and post-test scores that showed a significant reduction in VAS (Rest & Activity) scores from the pre-test to both post-test intervals (2 weeks and 4 weeks), indicating a strong effect of the intervention. There was a significant improvement in the T-test, dynamic balance, and 50 Meter Dash Test.

Table 2. Descriptive Statistics of Female Runners

Variable	Mean±SD
Age (in years)	23.5±3.47
Height (in cm)	170.8±8.05
Weight (in kgs)	66.4±7.32
BMI (kg cm-2)	22.7±2.29
LLD R (cm)	89.3±8.00
LLD L (cm)	89.6±8.18

SD: Standard deviation; cm: centimeters; kgs: Kilograms; LLD: Limb leg length; R: Right; L: Left.

Table 3. Mean and Standard Deviation (Mean±SD) of various outcome measures at baseline (Pre-test), After 2 weeks (Post-test), and after 4 weeks (post-test), along with F-values, P-values, and partial Eta Squared values.

Outcome Variables	Pre-test (Baseline Data)	Post-test (After-2 weeks)	Post-test (After-4 weeks)			
	Mean±SD	Mean±SD	Mean±SD	F value	P value	Partial Eta Sq. Value
VAS (Rest)	3.97±1.03	1.00±0.81	0.32±0.47	175.7	0.001*	0.798
VAS (Activity)	4.67±0.95	1.13±0.80	0.61±0.49	245.6	0.001*	0.847
T-Test (secs)	12.39±0.81	11.03±0.70	9.71±0.72	97.8	0.001*	0.687
ANT (mSEBT)	15.38±1.39	16.32±1.35	16.34±1.33	4.78	0.011*	0.097
PM (mSEBT)	14.81±1.63	15.81±1.62	15.81±1.62	3.76	0.027*	0.078
PL (mSEBT)	14.68±1.36	15.68±1.34	15.68±1.34	5.44	0.006*	0.109
50m Dash Test (secs)	9.70±0.98	8.80±1.11	7.38±1.13	35.5	0.001*	0.447

Note: *Indicates significant difference in Post 4th week than pre-treatment with $p<0.05$; VAS: Visual analog scale; mSEBT: modified Star excursion balance test; ANT: Anterior; PM: Posteromedial; PL: Posterolateral; Secs: Seconds; SD: Standard deviation; m: meter.

Discussion

The present study investigated the effectiveness of combined iliopsoas release techniques and core-strengthening exercises on agility, balance, running speed, and pain perception among female runners experiencing anterior hip pain. Our study findings are consistent with previous research indicating notable enhancements in balance ability through a six-week core training regimen among college athletes [21]. Kahle et al. (2009) similarly observed improvements in dynamic postural control following six weeks of core training as part of injury treatment and rehabilitation [22].

Additionally, Iacono et al. (2014) reported significant improvements in static and dynamic balance among young football players after a four-week, five-days-a-week core balance training program incorporating 11 exercises [23]. Similarly, Granacher et al. (2014) noted significant increases in balance metrics among football players when comparing two different six-week core training programs utilizing stable and unstable surfaces [24].

Prior studies have indicated notable enhancements in agility and speed skills with the integration of an eight-week, four-day-a-week core training program into football players' regular training regimen [25]. Our findings underscore that core stabilization exercises in runners not only enhance core stability but also have a significant impact on running performance. This aligns with prior research investigating the effects of a six-week Swiss ball training program on core stability and running economy among athletes. The study demonstrated statistical improvements in VO2 max among participants in the core exercise group following the six-week training period [26].

In addition to Stanton's study, Samson investigated the effects of a five-week core stabilization program on dynamic balance. The program included exercises like multidirectional lunges, wall squats, and stability ball crunches among others. The study found a significant improvement in dynamic balance from before the program to after [27]. Piegaro also demonstrated improvements in semi-dynamic balance [28]. Core muscles contribute not only to maintaining body posture but also play a crucial role in enhancing proprioception, balance, and energy transfer from the trunk to the lower limbs. As we interpret it, the activation of trunk muscles precedes the voluntary movement of the lower limbs. This suggests that abdominal muscles contract to stabilize the spine, establishing a steady base for controlling force and movement in the lower extremities. Key muscles involved include the transversus abdominis, multifidus, internal oblique, external oblique, paraspinal muscles, and pelvic floor musculature, all crucial for stabilizing the pelvis and lumbar spine while supporting the lower limbs during running or agility tests [25].

This result reinforces our hypothesis, which is in line with various studies. Ozmen and Aydogmus observed that six weeks of core stability training (CST) enhanced dynamic balance among badminton players [11]. Previous research found that competitive track and field athletes experienced slower 50-meter sprint times (indicating decreased performance) following passive static stretching or release, even when combined with active dynamic stretching. In contrast, they noted faster 50-meter sprint times (indicating improved performance) when warm-ups included static dynamic stretches combined with active dynamic stretches, or when using active dynamic stretches alone [29].

Limitations

Firstly, the study included a small sample size of 30 participants recruited from a single sports academy, which may restrict the generalizability of findings to broader populations of female runners. Secondly, the short-term follow-up period of up to 4 weeks limits understanding the long-term sustainability of intervention effects. Lastly, strict exclusion criteria while important for keeping the study strong, might mean that the results don't apply as well to runners with different medical histories.

Recommendations for future research

Future research could explore longer-term effects by conducting studies with extended follow-up periods beyond 4 weeks. Including more diverse participant groups from various geographical locations and athletic backgrounds would enhance the generalizability of findings. Integrating biomechanical assessments and qualitative measures could provide deeper insights into the physiological and subjective impacts of interventions on female runners.

Conclusion

The study concluded that combined iliopsoas release techniques and core-strengthening exercises significantly improve agility, balance, and running speed, and reduce pain perception among female runners experiencing anterior hip pain.

Clinical relevance of the study

This study's findings highlight that a combined approach of iliopsoas release techniques and core-strengthening exercises can effectively improve agility, balance, and running speed, and reduce pain perception in female runners with anterior hip pain. These insights are valuable for clinicians and sports professionals in designing effective rehabilitation and performance enhancement programs tailored to female athletes' specific needs.

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Conflict of interest

The authors disclose that there are no conflicts of interest related to this study.

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