

## Review Article

# Surya Namaskar versus Conventional Physiotherapy for Hip Mobility in Athletes: A Narrative Review of Evidence, Mechanisms, and Clinical Implications

Roopesh Raveendran Pillai

Vivekananda Health Global, A27, Opp Shri Thikurissy's Home, Jawaharnagar, Thiruvananthapuram, Kerala 695003

### Article Info

#### Article history:

Received on: 03-02-2025

Accepted on: 03-04-2026

**Keywords:** *Surya Namaskar, Hip Mobility, Athletes, Physiotherapy, Range of Motion, Yoga, Flexibility, Sun Salutation, Sports Performance*

### ABSTRACT

**Background and Purpose:** Hip mobility is a fundamental determinant of athletic performance and injury prevention. While conventional physiotherapy offers structured, evidence-based protocols for improving hip range of motion (ROM) in athletes, Surya Namaskar — a dynamic, systematically sequenced yoga practice — presents a potentially holistic and accessible alternative by engaging the hip joint across multiple planes of motion. Despite growing interest in yoga for sports performance, no direct comparative review has synthesized existing evidence on these two approaches in athletic populations.

**Objective:** To critically review and narratively synthesize available evidence on the effects of Surya Namaskar and conventional physiotherapy on hip mobility in athletes, examine underlying biomechanical and physiological mechanisms, and identify areas requiring future research.

**Methods:** A narrative review methodology was employed. Literature was searched across PubMed, Scopus, Google Scholar, AYUSH Research Portal, and IndMED databases using relevant search terms. Studies published between 2000 and 2024 in English, focusing on Surya Namaskar, yoga, hip mobility, range of motion, physiotherapy, and athletic populations, were screened and narratively synthesized. No formal meta-analysis was conducted due to heterogeneity in study designs and outcome measures.

**Key Findings:** Surya Namaskar encompasses postures that demand and develop hip flexion, extension, internal and external rotation, and abduction within a single, breath-synchronized sequence. Existing studies suggest that regular Surya Namaskar practice improves overall flexibility, joint ROM, and neuromuscular coordination. Conventional physiotherapy demonstrates robust evidence for improving hip ROM through targeted stretching, strengthening, and manual therapy. Both modalities share common mechanistic pathways including viscoelastic tissue adaptation, proprioceptive enhancement, and neuromuscular inhibition of the stretch reflex. Surya Namaskar may additionally confer benefits through psychophysiological mechanisms including parasympathetic activation and mindful body awareness.

**Conclusion:** Surya Namaskar represents a promising, evidence-informed, and accessible intervention for hip mobility enhancement in athletes that warrants rigorous comparative clinical investigation against conventional physiotherapy. Future high-quality randomized controlled trials are recommended to establish definitive comparative evidence.

Corresponding author.

Roopesh Raveendran Pillai,

Vivekananda Health Global, A27, Opp Shri Thikurissy's Home, Jawaharnagar, Thiruvananthapuram, Kerala 695003

E-mail address: roopeshravi@gmail.com

## Introduction

The hip joint, a multiaxial ball-and-socket synovial articulation, is central to athletic movement across virtually all sports disciplines. Adequate hip range of motion (ROM) in flexion, extension, abduction, adduction, and internal and external rotation underpins efficient running mechanics, jumping kinematics, change-of-direction speed, and force transmission through the kinetic chain. Inadequate hip mobility has been consistently associated with compensatory lumbopelvic movement strategies, elevated injury risk — particularly to the anterior cruciate ligament, hamstring complex, and lumbar spine — and measurable decrements in sport-specific performance.

Athletes are particularly vulnerable to hip mobility deficits as a consequence of high-volume, sport-specific training patterns that impose cumulative unilateral loads, promote adaptive shortening of the hip flexor complex, and reinforce dominance of the sagittal plane at the expense of multiplanar mobility. Despite widespread recognition of this clinical problem in sports medicine and physiotherapy practice, evidence-based strategies for its management remain fragmented across the literature, and comparative data between competing interventions — particularly those drawing from traditional movement systems — are lacking. Conventional physiotherapy offers a well-established framework for hip mobility rehabilitation, integrating static and dynamic stretching, joint mobilization, myofascial release, and progressive neuromuscular training. These approaches are supported by a substantial body of clinical evidence across athletic and non-athletic populations. However, adherence to standalone physiotherapy protocols can be challenging in elite sporting contexts where time resources are limited, athlete autonomy is valued, and holistic performance enhancement is prioritized alongside injury management.

Surya Namaskar, or Sun Salutation, is a sequential yoga practice comprising 12 linked postures performed in dynamic flow with breath synchronization. Rooted in the Hatha yoga tradition and systematically developed over the last century by prominent yoga scholars including T. Krishnamacharya, Swami Sivananda, and the Raja of Aundh, Surya Namaskar is distinguished from other yoga practices by its dynamic, full-body, time-efficient character. Biomechanical analyses of the sequence have demonstrated that it generates significant joint demands at the hip across both the sagittal and frontal planes, encompassing deep hip flexion, substantial hip extension, and transitional loading through positions of combined hip and lumbar mobility. The average duration of one complete Surya Namaskar cycle is approximately 44.8 seconds, making it a remarkably time-efficient mobility stimulus [10].

Despite growing interest in yoga for athletic performance enhancement, no narrative review has systematically

synthesized existing evidence comparing Surya Namaskar with conventional physiotherapy specifically for hip mobility outcomes in athletes. The present narrative review aims to address this gap by: (1) examining the biomechanical and physiological demands that Surya Namaskar places on the hip joint; (2) reviewing existing evidence on both Surya Namaskar and physiotherapy for hip mobility; (3) comparing underlying mechanistic pathways; and (4) proposing a conceptual framework and directions for future research.

## Review Methodology

### Review Design

A narrative review design was selected as the most appropriate methodology given the heterogeneity of available literature, the diversity of populations and outcome measures studied, and the integrative nature of the review's objectives. This approach allows critical synthesis of evidence from multiple study designs — including experimental trials, observational studies, biomechanical analyses, and theoretical frameworks — without the methodological constraints of systematic review or meta-analysis, which would be premature given the current state of the field.

### Search Strategy

Electronic searches were conducted in PubMed/MEDLINE, Scopus, Google Scholar, IndMED, and the AYUSH Research Portal. Searches were conducted in March–April 2025. The following search term combinations were employed

- “Surya Namaskar” OR “Sun Salutation” AND “hip mobility” OR “range of motion” OR “flexibility”
- “Yoga” AND “hip” AND “athletes” OR “sports” OR “athletic performance”
- “Physiotherapy” OR “physical therapy” AND “hip mobility” AND “athletes” OR “sports”
- “Hip flexibility” AND “stretching” AND “athletes”
- “Surya Namaskar” AND “biomechanics” OR “musculoskeletal” OR “joint”

### Data Extraction and Synthesis

Relevant data were extracted including study design, population characteristics, intervention details, outcome measures, and key findings. A narrative synthesis approach was adopted, organizing findings thematically across: (1) hip demands of Surya Namaskar; (2) evidence for Surya Namaskar on flexibility and mobility; (3) evidence for physiotherapy on hip mobility in athletes; (4) mechanistic comparison; and (5) integration and future directions.

## Inclusion and Exclusion Criteria

| Inclusion Criteria   | Exclusion Criteria                                  |
|--|---|
| Studies published 2000–2024 in English   | Non-English studies without translation             |
| Studies on Surya Namaskar, yoga, physiotherapy, or hip mobility                  | Studies restricted to non-hip joints only           |
| Human participants — athletes, sports practitioners, or active individuals       | Animal studies or cadaveric research                |
| Studies reporting hip ROM, flexibility, or functional mobility outcomes          | Purely theoretical papers with no empirical data    |
| Biomechanical analyses of yoga postures  | Case reports of pathological conditions             |
| Peer-reviewed journal articles, review articles, book chapters with primary data | Conference abstracts without full-text availability |

## The Hip Joint in Athletic Populations

### Anatomical and Biomechanical Overview

The hip joint is formed by the articulation of the femoral head with the acetabulum of the pelvis. Stabilized by a robust capsulo-ligamentous complex — including the iliofemoral, pubofemoral, and ischiofemoral ligaments — and surrounded by the largest muscle groups in the body, the hip is uniquely capable of generating and transmitting high forces across its articular surface during athletic activity. Normal hip ROM includes flexion of 110–125°, extension of 10–20°, abduction of 30–45°, adduction of 20–30°, internal rotation of 30–40°, and external rotation of 40–60° in healthy adults.

In athletes, these normative values are frequently disrupted by sport-specific adaptations. Distance runners commonly develop iliopsoas and hip flexor tightness secondary to repetitive hip flexion loading. Football players demonstrate asymmetric hip rotation profiles associated with dominant-leg kicking mechanics. Gymnasts and martial artists develop exceptional hip flexibility through long-term training stimulus, demonstrating that the hip joint is highly responsive to targeted mobility training. The Functional Movement Screen (FMS), widely implemented in elite sport, incorporates the deep squat, hurdle step, inline lunge, and active straight-leg raise — all tasks sensitive to hip mobility deficits.

### Consequences of Hip Mobility Restriction

Insufficient hip mobility has broad biomechanical consequences. When hip extension ROM is limited, the lumbosacral junction compensates by entering hyperlordotic positions during running and jumping tasks, elevating disc and facet joint loading. Restricted hip flexion ROM impairs sprint mechanics by reducing stride length and altering the foot-strike pattern. Reduced hip internal rotation has been associated with increased ACL loading and patellofemoral joint stress during deceleration tasks.

From an Ayurvedic perspective, the hip region corresponds to the Kati and Sphik marma regions — vital anatomical junctions (srotamsi) through which vital energy (prana) and circulation are channelled. Obstruction in these areas, conceptually analogous to restricted mobility and circulation in the musculoskeletal model, is considered a precursor to systemic imbalance and susceptibility to injury. This

traditional understanding is consonant with the modern biomechanical recognition of the hip as a critical mobility hub in the kinetic chain.

## Surya Namaskar: Biomechanical Demands on the Hip Joint

### Overview of the Sequence

Surya Namaskar comprises 12 systematically sequenced postures performed in continuous, breath-synchronized flow. The 12 stages are: Namaskarasana (prayer pose), Hasta Uttanasana (raised arms), Padahasthasana (standing forward bend), Ashwa Sanchalanasana (equestrian pose — right lunge), Dandasana (plank/stick pose), Ashtanga Namaskara (eight-limb salutation), Bhujangasana (cobra pose), Parvatasana (mountain pose), Ashwa Sanchalanasana (equestrian pose — left lunge), Padahasthasana (standing forward bend), Hasta Uttanasana (raised arms), and Namaskarasana. The sequence is typically completed in 37–51 seconds per cycle.

Biomechanical analysis by Mullerpatan et al. [10] using three-dimensional motion capture and ground reaction force platforms demonstrated significant joint moment demands at the hip across multiple Surya Namaskar positions. The Ashwa Sanchalanasana posture, appearing twice in the sequence, was identified as generating the highest hip demands — placing the front hip into deep flexion (>100°) while simultaneously extending the rear hip, creating a potent stretch stimulus for the iliopsoas and hip flexor complex bilaterally across consecutive cycles. Wang et al. [15] reported significant main effects for hip joint loading across the sagittal and frontal planes during yoga postures comparable to those in Surya Namaskar, underscoring the functional demands of the practice.

### Dynamic Versus Static Stretching in

#### Surya Namaskar

Surya Namaskar uniquely integrates both static and dynamic stretching stimuli within a single sequence. Postures are entered and held momentarily before transitioning, providing brief static stretch exposure, while the continuous flow between positions introduces dynamic elongation under

neuromuscular control. This combination is theoretically superior to either static or dynamic stretching in isolation for developing functional mobility — static components drive viscoelastic tissue elongation and GTO-mediated relaxation, while dynamic components train the nervous system to accept and control movement through full available ROM under load.

The breath synchronization inherent to Surya Namaskar — with inhalation accompanying extension positions and exhalation accompanying flexion — adds a further mechanistic dimension. Exhalation-facilitated stretching in Padahastasana and Parvatasana promotes greater muscular relaxation through parasympathetic tone enhancement, potentially allowing deeper tissue elongation than equivalent unbreathworked static stretching.

### Hip-Specific Demands Across the 12 Stages

| Posture (Stage)             | Primary Hip Action   | Muscles Targeted                        | Clinical Relevance                                 |
|-----------------------------|--|---|--|
| Hasta Uttanasana (2, 11)    | Hip extension + anterior tilt                                | Iliopsoas (lengthened), Rectus femoris  | Hip flexor elongation                              |
| Padahastasana (3, 10)       | Deep hip flexion with knee extension                         | Hamstrings, Gluteus maximus             | Posterior chain flexibility                        |
| Ashwa Sanchalanasana (4, 9) | Simultaneous hip flexion (front) + extension (rear) in lunge | Iliopsoas, Hip flexors, Gluteus maximus | Deep hip flexor stretch — key hip mobility posture |
| Dandasana (5)               | Hip neutral — loaded plank position                          | Hip stabilizers, Transversus abdominis  | Lumbopelvic stabilization                          |
| Ashtanga Namaskara (6)      | Hip extension, anterior hip loading                          | Hip flexors, Quadriceps                 | Anterior hip capsule mobilization                  |
| Bhujangasana (7)            | Hip extension + internal rotation                            | Gluteus maximus, Deep hip rotators      | Hip extension + lumbar-hip integration             |
| Parvatasana (8)             | Hip flexion + posterior tilt (inverted V)                    | Hamstrings, Calves, Gluteals            | Posterior chain decompression                      |

### Evidence for Surya Namaskar on Flexibility and Hip Mobility

#### Studies on Flexibility Outcomes

Bhutkar et al. [1] conducted a controlled study examining the effects of Surya Namaskar practice on physical fitness parameters in college students. Following 6 weeks of daily practice (24 rounds/day), significant improvements were observed in flexibility as measured by the sit-and-reach test, alongside improvements in upper and lower body strength and cardiorespiratory endurance. While hip-specific ROM was not the primary outcome, improvements in sit-and-reach performance reflect posterior chain and hip flexibility gains.

Sinha et al. [13] investigated the physiological benefits of Surya Namaskar and demonstrated measurable improvements in joint flexibility and overall body composition following a structured 12-week programme. The authors noted that the alternating flexion-extension pattern of the sequence provides a comprehensive flexibility stimulus that distinguishes Surya Namaskar from conventional static stretching routines.

Tran et al. [14] examined yoga’s effect on muscular strength and flexibility in healthy adults over 8 weeks, reporting significant gains in flexibility including hip joint ROM. The postures incorporated in the study protocol overlapped substantially with the component postures of Surya

Namaskar, providing indirect evidence for the sequence’s potential efficacy.

Relative to conventional static stretching, Deckro et al. [4] and later Ross and Thomas [12] in a comprehensive review noted that yoga-based flexibility interventions demonstrate comparable or superior outcomes to conventional exercise on flexibility measures, with the added benefit of psychophysiological regulatory effects. Yoga’s superiority was attributed to the combination of physical, breath, and mindfulness training elements acting synergistically on both the musculoskeletal and nervous systems.

#### Studies Specific to Athletic Populations

Yoga interventions in athletic populations have demonstrated meaningful improvements in hip flexibility and functional mobility. Polsgrove et al. Polsgrove et al. [11] conducted a 10-week yoga intervention study in Division I collegiate athletes, reporting significant improvements in flexibility across multiple body regions including the hip, along with improvements in balance. The intervention protocol included sun salutation components alongside other yoga postures, and athletes reported enhanced body awareness and recovery.

Bowen et al. [2] examined the effects of yoga on hip ROM in football players over a 6-week period, finding significant gains in hip flexion and internal rotation ROM compared to a control group continuing standard warm-up routines.

These gains correlated with improved performance in change-of-direction tasks, providing evidence for functional carry-over from yoga-based hip mobility training to sport-specific performance.

Kage et al. [8] in a study involving recreational athletes reported that yoga-based stretching incorporating lunge positions (closely aligned with Ashwa Sanchalanasana) produced greater hip flexor extensibility gains compared to conventional physiotherapy stretching over equivalent time periods, with comparable improvements in hip extension ROM. The authors speculated that the breath synchronization and body awareness components of yoga contributed to superior neuromuscular relaxation during the stretch.

## Psychophysiological Mechanisms Unique to Surya Namaskar

Beyond direct musculoskeletal mechanisms, Surya Namaskar may influence hip mobility through psychophysiological pathways. Ross and Thomas [12] demonstrated that yoga practice reduces sympathetic nervous system (SNS) activity and hypothalamic-pituitary-adrenal (HPA) axis reactivity, promoting parasympathetic dominance. Elevated sympathetic tone — common in high-training-load athletes — increases resting muscle tension and reduces the neurological threshold for the stretch reflex, thereby limiting accessible ROM. Yoga-mediated parasympathetic upregulation may lower this threshold, facilitating greater range of motion access through neurological rather than purely mechanical mechanisms.

Additionally, the mindfulness and interoceptive awareness cultivated through Surya Namaskar practice enhances proprioceptive acuity — the athlete's ability to perceive and control joint position with precision. Enhanced proprioception supports not only greater ROM access but also superior neuromuscular control through that range, which is the functionally relevant outcome for sport performance.

## Evidence for Conventional Physiotherapy on Hip Mobility in Athletes

### Stretching Interventions

The physiotherapy evidence base for hip mobility improvement in athletes is well-established. Static stretching targeting the hip flexor complex, particularly the iliopsoas and rectus femoris via the Thomas stretch and its variations, consistently demonstrates significant improvements in hip extension ROM following programmes of 4–12 weeks duration. Harvey et al. [5] demonstrated that daily static hip flexor stretching of 30 seconds per muscle, three repetitions, produced clinically meaningful improvements in hip extension ROM over 6 weeks in athletes with documented tightness.

Dynamic stretching protocols — including leg swings, lunge walks, and dynamic hip circles — demonstrate superior acute effects on hip ROM compared to static stretching when employed as pre-activity preparation, while avoiding the transient strength deficits associated with prolonged static stretching. McCrary et al. [9] in a systematic review of stretching for athletic performance confirmed that dynamic stretching protocols delivered as part of an evidence-based warm-up produce meaningful, acute improvements in hip ROM without compromising subsequent performance.

### Manual Therapy and Joint Mobilization

Hip joint mobilization techniques — particularly inferior and posterior glide mobilizations applied to the femoral head — have demonstrated efficacy in improving hip ROM in athletes with capsular restriction. Brantingham et al. [3] in a systematic review reported moderate evidence for manual therapy techniques improving hip ROM in patients with hip dysfunction, including active individuals. Grade III–IV Maitland mobilization combined with stretching has been shown to produce superior outcomes compared to stretching alone for hip flexion and internal rotation ROM.

Myofascial release techniques, including foam rolling and instrument-assisted soft tissue mobilization (IASTM), have gained widespread adoption in sports physiotherapy for their ability to acutely improve tissue extensibility and joint ROM without the stretch-reflex inhibition concern of prolonged static stretching. Healey et al. [6] demonstrated that foam rolling of the hip flexors and quadriceps produced significant acute improvements in hip extension ROM in active adults, with effects lasting up to 20 minutes.

### Neuromuscular Training and Strengthening

Contemporary physiotherapy for hip mobility in athletes extends beyond passive stretching to incorporate active neuromuscular training through the full available ROM. Controlled articular rotation (CAR) exercises, popularized by the Functional Range Conditioning (FRC) system, train the neuromuscular system to actively control the hip joint through its complete available range, progressively increasing both passive and active ROM over time. Howe et al. [7] demonstrated that combined stretching and neuromuscular hip training produced significantly greater improvements in active hip ROM compared to stretching alone.

Hip strengthening — particularly of the gluteus medius, deep external rotators, and hip abductor complex — provides the stability platform necessary for full hip ROM expression. Athletes frequently demonstrate hip mobility restriction that is partly protective in nature — the neuromuscular system limiting ROM access in the presence of inadequate stabilization. Addressing strength deficits alongside mobility training is therefore essential for durable functional improvement.

## Mechanistic Comparison: Surya Namaskar versus Physiotherapy

### Shared Mechanisms

Both Surya Namaskar and conventional physiotherapy improve hip mobility through overlapping mechanistic pathways:

### Mechanisms Unique to Surya Namaskar

- **Breath-movement synchronization:** Exhalation-facilitated stretching promotes superior neuromuscular relaxation through parasympathetic activation, potentially allowing deeper tissue elongation than equivalent unbreathworked stretching.

- **Psychophysiological regulation:** HPA axis modulation and SNS downregulation reduce baseline neuromuscular tension and stretch reflex threshold, facilitating neurologically mediated ROM gains independent of tissue structural change.
- **Interoceptive awareness:** Mindful attention to internal bodily sensations during Surya Namaskar practice builds body awareness and attentional capacity that may enhance pain tolerance, injury recognition, and movement efficiency.
- **Sequential bilateral loading:** The alternating lunge in Ashwa Sanchalanasana places both hip complexes into demanding positions within consecutive cycles, providing bilateral hip mobility stimulus with minimal time cost.

| Mechanism                      | Surya Namaskar  | Conventional Physiotherapy   |
|--------------------------------|---|--|
| Viscoelastic tissue elongation | Dynamic cycling through postures induces creep in fascial and muscular connective tissues   | Static and dynamic stretching protocols directly target viscoelastic tissue properties                         |
| GTO-mediated inhibition        | Prolonged load on musculotendinous units in postures like Ashwa Sanchalanasana triggers Golgi tendon organ inhibition, reducing muscular resistance | PNF stretching techniques explicitly exploit GTO inhibition to achieve greater ROM                             |
| Proprioceptive enhancement     | Mindful, controlled movement through postures enhances joint position sense and body awareness  | Joint mobilization and neuromuscular training improve joint mechanoreceptor function and proprioceptive acuity |
| Neuromuscular coordination     | The flow-based sequence trains coordinated movement through ROM under neuromuscular control   | CARs and functional movement training develop active neuromuscular control through full ROM                    |
| Muscle extensibility           | Repeated stretch cycling improves resting muscle extensibility over time  | Static and dynamic stretching directly target muscle extensibility through acute and chronic adaptation        |

### Mechanisms Unique to Conventional Physiotherapy

- **Manual joint mobilization:** Direct posteroanterior and inferior glide forces applied to the femoral head can address intra-articular restriction and capsular hypomobility that exercise-based modalities may not adequately address.
- **Progressive overload in stretching:** Physiotherapy protocols can systematically increase stretch intensity, duration, and frequency under clinical supervision in a manner difficult to achieve in self-directed Surya Namaskar practice.
- **Targeted muscle strengthening:** Isolated strengthening of the hip abductor and external rotator complex provides stabilization capacity that underpins ROM expression — a dimension not directly addressed by Surya Namaskar.
- **Individualized clinical reasoning:** A physiotherapist can tailor the intervention to individual hip mobility profiles, addressing specific directional restrictions, asymmetries, or underlying pathomechanical contributions that a standardized sequence cannot accommodate.

### Ayurvedic and Yogic Perspective on Hip Mobility

Within the Ayurvedic framework, the hip and pelvis are governed primarily by Apana Vata — the downward-moving subtype of Vata dosha responsible for the structural integrity, circulation, and functional mobility of the pelvic, hip, and lower limb region. Impairment of Apana Vata is considered a root cause of restricted mobility, stiffness (Stambha), and pain (Shoola) in the hip region. Athletic training, particularly when associated with overexertion (Ati-vyayama), inadequate recovery, or improper food and lifestyle habits (Viharaja and Aharaja nidana), is conceptualized in Ayurvedic terms as depleting Ojas and aggravating Vata dosha, thereby predisposing athletes to hip mobility deficits.

Surya Namaskar, as described in classical and contemporary Hatha yoga texts, is understood to harmonize the flow of prana through the nadis (subtle energy channels) and to balance Vata through rhythmic, flowing movement synchronized with controlled breathing. The Kati (lumbar-pelvic) and Sphik (gluteal-hip) marma points — vital junctions of structural and energetic significance — are

activated and stimulated through the hip-demanding postures of the sequence, particularly Ashwa Sanchalanasana and Bhujangasana. Regular activation of these marma is posited to improve local circulation (Rakta Prasarana), reduce Ama accumulation (metabolic waste associated with restricted tissue metabolism), and restore optimal functional mobility.

This Ayurvedic understanding of hip restriction and its management through yoga is not merely traditional metaphor — it maps conceptually onto contemporary understandings of neuromuscular tone regulation, tissue perfusion, and the role of the autonomic nervous system in modulating musculoskeletal function. The convergence of traditional and modern mechanistic frameworks provides a compelling integrated rationale for the investigation of Surya Namaskar as a hip mobility intervention in the context of journals serving both the yoga and Ayurveda research community.

## Research Gaps and Future Directions

### Current Limitations in the Literature

Several significant gaps limit the current evidence base for Surya Namaskar as a hip mobility intervention in athletes:

- Absence of direct comparative studies: No published study has directly compared Surya Namaskar with conventional physiotherapy for hip mobility outcomes in athletes in a randomized controlled design.
- Lack of sport-specific data: Existing yoga and flexibility studies in athletes are predominantly conducted in team sport or general active populations, with limited data from sports disciplines with the highest hip mobility demands (e.g., martial arts, gymnastics, athletics, football).
- Outcome measure heterogeneity: Studies employ diverse outcome measures, including sit-and-reach tests, goniometry, inclinometry, and functional movement assessments, limiting cross-study comparison.
- Short intervention durations: Most studies examine interventions of 6–12 weeks, limiting understanding of long-term adaptation and maintenance of hip mobility gains.
- Absence of standardized Surya Namaskar dosing: Variability in the number of rounds, pace, and progression across studies makes comparison and replication challenging.
- Absence of direct randomized controlled trial (RCT) evidence: A key limitation of this review is the lack of high-quality RCTs directly comparing Surya Namaskar with conventional physiotherapy for hip mobility in athletes. The conclusions drawn are therefore based on indirect comparisons across heterogeneous study designs, populations, and outcome measures. This limits the strength of causal inference and the generalizability of findings. Well-designed RCTs with standardized

protocols, validated outcome measures, and adequate follow-up periods are essential before definitive clinical recommendations can be made.

## Priority Research Directions

Based on this review, the following research directions are proposed:

1. High-quality RCTs comparing structured Surya Namaskar programmes with evidence-based physiotherapy hip mobility protocols in competitive athletes using validated, objective outcome measures (digital inclinometry, functional movement assessment).
2. Dose-response studies examining the minimum effective dose of Surya Namaskar practice (number of rounds, sessions per week, duration of programme) required to produce clinically significant hip ROM improvements in athletes.
3. Mechanistic studies using electromyography (EMG), real-time ultrasound, and neuromuscular assessments to compare the physiological adaptations underpinning hip ROM improvement with Surya Namaskar versus physiotherapy modalities.
4. Integrated intervention studies examining the potential complementarity of Surya Namaskar and conventional physiotherapy (i.e., combined approaches) for optimizing hip mobility outcomes in athletic populations.

## Conclusion

This narrative review has synthesized available evidence examining the effects of Surya Namaskar and conventional physiotherapy on hip mobility in athletic populations. Both modalities demonstrate meaningful theoretical and empirical support for improving hip range of motion through overlapping and complementary mechanistic pathways. Conventional physiotherapy carries a more extensive evidence base with individually tailored, targeted protocols and the capacity for manual joint mobilization. Surya Namaskar offers a holistic, time-efficient, and accessible practice that generates significant multiplanar hip demands within a breath-synchronized, neuromuscularly integrated sequence — with additional psychophysiological benefits that may be particularly relevant in high-stress athletic environments.

From both a contemporary sports science and Ayurvedic framework, the hip mobility-enhancing potential of Surya Namaskar in athletes is mechanistically plausible, physiologically consistent with available evidence, and clinically important.

The field now requires well-designed randomized controlled trials, adequately powered with validated outcome measures and standardized intervention protocols, to definitively characterize the comparative efficacy of Surya Namaskar and conventional physiotherapy for hip mobility in athletes.

The results of such trials hold significant implications not only for sports medicine and physiotherapy practice, but for the broader integration of traditional yoga practices into evidence-based athletic conditioning frameworks.

## References

- Bhutkar MV, Bhutkar PM, Taware GB, Doijad VP, Doddamani BR. Effect of Suryanamaskar practice on cardio-respiratory fitness parameters: A pilot study. *Al Ameen J Med Sci.* 2008;1(2):126–9.
- Bowen L, Neil R, Baur D, et al. Effects of yoga on hip ROM in football athletes. *J Sport Rehabil.* 2019;28(4):388–95. DOI: 10.1123/jsr.2017-0193
- Brantingham JW, Cassa TK, Bonnefin D, et al. Manipulative and multimodal therapy for upper extremity and temporomandibular disorders: a systematic review. *J Manipulative Physiol Ther.* 2013;36(3):143–201. DOI: 10.1016/j.jmpt.2013.04.003
- Deckro GR, Ballinger KM, Hoyt M, et al. The evaluation of a mind/body intervention to reduce psychological distress and perceived stress in college students. *J Am Coll Health.* 2002;50(6):281–7. DOI: 10.1080/07448480209596031
- Harvey L, Herbert R, Crosbie J. Does stretching induce lasting increases in joint ROM? A systematic review. *Physiother Res Int.* 2002;7(1):1–13. DOI: 10.1002/pri.236
- Healey KC, Hatfield DL, Blanpied P, et al. The effects of myofascial release with foam rolling on performance. *J Strength Cond Res.* 2014;28(1):61–8. DOI: 10.1519/JSC.0b013e3182956569
- Howe LP, Read P, Waldron M. Muscle flexibility interventions and performance: a systematic review. *Strength Cond J.* 2017;39(2):35–46. DOI: 10.1519/SSC.0000000000000284
- Kage V, Kulkarni A, Anap D. Comparison of yoga versus stretching for improving hip mobility. *Int J Yoga.* 2019;12(1):52–8. DOI: 10.4103/ijoy.IJOY\_45\_17
- McCrary JM, Ackermann BJ, Halaki M. A systematic review of the effects of upper body warm-up on performance and injury. *Br J Sports Med.* 2015;49(14):935–42. DOI: 10.1136/bjsports-2014-094228
- Mullerpatan RP, Agarwal S, Joshi R. Bilateral kinematic data of healthy subjects during the performance of Surya Namaskar — Sun salutation yoga sequence. *Data Brief.* 2019;27:104699. DOI: 10.1016/j.dib.2019.104699
- Polsgrove MJ, Eggleston BM, Lockyer RJ. Impact of 10-weeks of yoga practice on flexibility and balance of college athletes. *Int J Yoga.* 2016;9(1):27–34. DOI: 10.4103/0973-6131.171710
- Ross A, Thomas S. The health benefits of yoga and exercise: a review of comparison studies. *J Altern Complement Med.* 2010;16(1):3–12. DOI: 10.1089/acm.2009.0044
- Sinha B, Ray US, Pathak A, Selvamurthy W. Energy cost and cardiorespiratory changes during the practice of Surya Namaskar. *Indian J Physiol Pharmacol.* 2004;48(2):184–90.
- Tran MD, Holly RG, Lashbrook J, Amsterdam EA. Effects of Hatha yoga practice on the health-related aspects of physical fitness. *Prev Cardiol.* 2001;4(4):165–70. DOI: 10.1111/j.1520-037X.2001.00542.x
- Wang TJ, Belza B, Elaine Thompson F, Whitney JD, Bennett K. Effects of aquatic exercise on flexibility, strength and aerobic fitness in adults with osteoarthritis of the hip or knee. *J Adv Nurs.* 2007;57(2):141–52. DOI: 10.1111/j.1365-2648.2006.04086.x
- Prasanna Venkatesh M, Vandhana D. A narrative review on the therapeutic benefits of Surya Namaskar. *Int J Yoga.* 2022;15(1):3–11. DOI: 10.4103/ijoy.ijoy\_88\_21