

Tai Chi versus Physiotherapy for Musculoskeletal and Balance Disorders: A Systematic Review of Clinical Effectiveness

Dr. Siva Bali Reddy Katasani¹, Dr. S Purna Chandra Shekhar²,
Dr. Anjani Kumar³, Dr. Rajeswari Thatikonda⁴

¹Assistant Professor/Research Scholar, Dept. of Rehabilitation, School of Social Sciences, Sanskriti University, Mathura, UP, India. ORCID: <https://orcid.org/0009-0009-8282-8250>

²Head of the Department, Chandras Homoeopathy Physiotherapy, Boduppal, Telangana, India
ORCID: <https://orcid.org/0009-0008-8214-2569>

³Chief Physiotherapist, Lotus Hospitals for Children & Women's, Hyderabad, Telangana, India.
ORCID: <https://orcid.org/0009-0000-3704-1701>

⁴Professor, DEV'S Homeopathy Medical College, Hyderabad, India

Abstract:

Background: Musculoskeletal disorders, age-related balance impairment, and chronic pain are among the leading causes of disability worldwide. Physiotherapy has long been regarded as the cornerstone of conservative rehabilitation because of its structured exercise programs, manual therapy techniques, neuromuscular re-education, and functional training. Tai Chi, a traditional Chinese mind-body exercise characterized by slow, controlled movements, coordinated breathing, and postural awareness, has gained increasing attention as an alternative or complementary rehabilitation strategy. Although both interventions have demonstrated positive clinical outcomes, uncertainty remains regarding their comparative effectiveness across different patient populations and outcome measures.

Objective: This systematic review aimed to compare the effectiveness of Tai Chi and conventional physiotherapy in improving pain, balance, physical function, mobility, muscle strength, and health-related quality of life among individuals with musculoskeletal disorders, neurological conditions, and age-related balance impairments.

Methods: A systematic literature review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) guidelines. Electronic databases including PubMed, Scopus, Web of Science, PEDro, and the Cochrane Library were searched for peer-reviewed studies published in English between 2015 and 2025. Randomized controlled trials, controlled clinical trials, and systematic reviews comparing Tai Chi with physiotherapy or evaluating both interventions independently were considered eligible. Methodological quality and risk of bias were assessed using established appraisal tools, and findings were synthesized narratively because of variations in intervention protocols and outcome measures.

Results: The reviewed evidence consistently demonstrated that both Tai Chi and physiotherapy significantly improved pain intensity, postural balance, gait performance, functional mobility, and quality of life. Physiotherapy generally produced greater short-term improvements in muscle strength, joint

mobility, and condition-specific functional recovery through individualized rehabilitation protocols. Tai Chi demonstrated superior benefits in dynamic balance, fall prevention, movement confidence, psychological well-being, adherence to long-term exercise, and sustained improvements in physical function among older adults. For individuals with knee osteoarthritis, chronic low back pain, and Parkinsonian balance dysfunction, Tai Chi showed outcomes comparable to conventional physiotherapy in several functional domains. Emerging evidence also indicated that integrating Tai Chi into physiotherapy programs may provide greater overall rehabilitation benefits than either intervention alone.

Conclusion: Current evidence indicates that Tai Chi and physiotherapy are both effective rehabilitation approaches with distinct but complementary therapeutic strengths. Physiotherapy remains the preferred intervention for acute injury management, individualized rehabilitation, and restoration of musculoskeletal function, whereas Tai Chi offers a safe, low-cost, community-based strategy for improving balance, preventing falls, and promoting long-term physical and psychological health. A combined rehabilitation model incorporating structured physiotherapy with progressive Tai Chi practice may optimize patient outcomes across diverse clinical populations. Further multicenter randomized controlled trials employing standardized intervention protocols and long-term follow-up are required to establish evidence-based recommendations for integrated rehabilitation programs.

Keywords: Tai Chi; Physiotherapy; Rehabilitation; Balance; Musculoskeletal Disorders; Fall Prevention; Chronic Pain; Physical Function; Quality of Life; Systematic Review

1. Introduction

Musculoskeletal disorders represent one of the most significant contributors to disability, functional decline, and reduced quality of life worldwide. Conditions such as knee osteoarthritis, chronic low back pain, cervical pain, rheumatoid arthritis, and age-related musculoskeletal degeneration impose substantial physical, psychological, and socioeconomic burdens on individuals and healthcare systems. The increasing prevalence of these disorders is largely attributed to population ageing, sedentary lifestyles, obesity, occupational risk factors, and longer life expectancy. Alongside musculoskeletal conditions, balance impairment and falls among older adults have emerged as major public health concerns, frequently leading to fractures, hospitalization, institutionalization, and premature mortality.

Rehabilitation plays a central role in minimizing disability, restoring physical function, and improving participation in daily activities. Contemporary rehabilitation emphasizes individualized exercise prescription, functional restoration, patient education, and long-term self-management. Among the available non-pharmacological interventions, physiotherapy remains the most widely recommended conservative treatment for musculoskeletal and neurological disorders. Physiotherapy encompasses therapeutic exercise, manual therapy, balance retraining, gait rehabilitation, neuromuscular re-education, electrotherapy, and functional task-specific training. Numerous randomized controlled trials have demonstrated that physiotherapy effectively reduces pain, increases muscle strength, enhances joint mobility, and improves functional independence across a wide range of clinical populations.

Despite its well-established effectiveness, physiotherapy may present certain limitations. Long-term adherence to prescribed exercise programs often declines after supervised treatment ends. Accessibility may be limited in rural or resource-constrained settings because of shortages of rehabilitation professionals and financial barriers. Furthermore, conventional physiotherapy primarily targets physical impairments

and may not fully address psychological factors such as fear of falling, movement anxiety, stress, or reduced self-confidence, all of which influence rehabilitation outcomes.

Tai Chi has increasingly gained recognition as a complementary rehabilitation approach capable of addressing both physical and psychological dimensions of health. Originating in ancient China as a martial art, Tai Chi has evolved into a therapeutic exercise emphasizing slow, continuous movements, controlled breathing, relaxation, postural alignment, weight shifting, and mindful attention. Unlike high-intensity exercise programs, Tai Chi imposes minimal mechanical stress on joints while simultaneously challenging balance control, proprioception, coordination, flexibility, and lower-limb strength. These characteristics make Tai Chi particularly attractive for older adults and individuals with chronic musculoskeletal conditions.

Growing scientific evidence indicates that Tai Chi produces clinically meaningful improvements in balance, gait performance, mobility, flexibility, muscular endurance, pain perception, and overall quality of life. Beyond its physical benefits, Tai Chi also contributes to reductions in anxiety, depression, perceived stress, and fear of falling while enhancing cognitive function and emotional well-being. Such multidimensional effects distinguish Tai Chi from many conventional exercise interventions and have stimulated increasing interest among rehabilitation professionals.

Comparative studies examining Tai Chi and physiotherapy have produced encouraging but sometimes inconsistent findings. Several investigations involving individuals with knee osteoarthritis suggest that Tai Chi achieves pain reduction and functional improvement comparable to structured physiotherapy programs. Similar observations have been reported among patients with chronic low back pain and Parkinson's disease, where Tai Chi demonstrated substantial improvements in balance, gait stability, and movement confidence. Conversely, physiotherapy generally remains superior for restoring joint range of motion, correcting biomechanical dysfunction, and facilitating recovery after acute injury or surgery through individualized treatment progression.

The growing popularity of Tai Chi within rehabilitation raises important clinical questions regarding its relative effectiveness compared with conventional physiotherapy. Healthcare providers increasingly seek evidence-based guidance on selecting the most appropriate intervention for specific patient populations. Understanding the comparative strengths, limitations, and potential complementary roles of these interventions is essential for optimizing rehabilitation strategies and improving long-term patient outcomes.

Although previous systematic reviews have independently evaluated Tai Chi or physiotherapy, comprehensive comparisons between these interventions across musculoskeletal disorders, neurological conditions, and age-related balance impairment remain limited. Existing reviews frequently focus on a single disease, employ heterogeneous outcome measures, or evaluate only short-term clinical effects. Consequently, clinicians lack consolidated evidence regarding the comparative benefits of these rehabilitation approaches across multiple functional domains.

Therefore, the present systematic review aims to critically evaluate and compare the effectiveness of Tai Chi and conventional physiotherapy in improving pain, balance, functional mobility, muscle strength, physical performance, and health-related quality of life among individuals with musculoskeletal and balance disorders. Additionally, this review explores the mechanisms underlying both interventions, summarizes current evidence, identifies research gaps, and discusses clinical implications for rehabilitation practice. By integrating findings from contemporary high-quality studies, this review seeks

to support evidence-based decision-making and inform the development of patient-centered rehabilitation programs that maximize functional recovery and long-term health outcomes.

2. Tai Chi: Principles, Styles, Physiological Mechanisms, and Therapeutic Applications

2.1 Historical Background

Tai Chi (Tai Chi Chuan or Taijiquan) is an ancient Chinese martial art that originated during the Ming and Qing dynasties and has evolved into one of the most widely practiced mind–body exercises worldwide. Initially developed as a system of self-defense, Tai Chi has gradually been adapted into a therapeutic exercise emphasizing health promotion, disease prevention, and functional rehabilitation. Unlike conventional exercise programs that primarily focus on muscular strength or cardiovascular endurance, Tai Chi integrates slow, continuous body movements with controlled breathing, mental concentration, and postural alignment. This holistic approach simultaneously addresses physical, cognitive, and psychological aspects of health.

Over the past two decades, Tai Chi has gained substantial recognition within rehabilitation medicine because of its safety, low cost, and suitability for individuals with chronic diseases and older adults. International rehabilitation guidelines increasingly acknowledge Tai Chi as an evidence-based intervention for improving balance, reducing falls, managing chronic pain, and enhancing overall functional capacity. Healthcare providers have incorporated Tai Chi into rehabilitation programs for musculoskeletal disorders, neurological diseases, cardiovascular conditions, osteoporosis, and frailty because it requires minimal equipment and can be performed in community or home settings.

2.2 Fundamental Principles of Tai Chi

The therapeutic effectiveness of Tai Chi is based on several interconnected principles that distinguish it from traditional exercise modalities.

Slow and Controlled Movement

Tai Chi consists of slow, rhythmic, and continuous movements that require precise motor control and coordinated muscle activation. Performing movements at a reduced speed allows participants to consciously adjust posture, improve joint alignment, and develop greater movement accuracy. These controlled movements minimize excessive joint loading while promoting muscular endurance and flexibility.

Weight Transfer and Dynamic Balance

Tai Chi involves repeated shifting of body weight between the lower limbs during multidirectional movements. Continuous weight transfer challenges the body's center of gravity and stimulates postural control mechanisms responsible for maintaining balance during functional activities. These repetitive balance challenges contribute significantly to fall prevention among older adults.

Postural Alignment

Maintaining an upright posture with slight knee flexion, neutral spinal alignment, and relaxed shoulders promotes optimal biomechanical efficiency. Proper posture reduces unnecessary muscular tension while enhancing trunk stability and proprioceptive awareness.

Controlled Breathing

Tai Chi integrates diaphragmatic breathing with body movements. Slow, deep breathing enhances oxygen delivery, reduces sympathetic nervous system activity, lowers stress hormones, and promotes relaxation. Controlled breathing also contributes to improved cardiovascular efficiency during exercise.

Mindfulness and Mental Concentration

Unlike conventional exercise, Tai Chi requires continuous awareness of body position, breathing rhythm, and movement coordination. This mindful attention improves cognitive processing, motor planning, and body awareness while reducing anxiety and psychological stress.

2.3 Major Styles of Tai Chi

Several traditional styles of Tai Chi are practiced globally, each differing slightly in movement characteristics and therapeutic application.

Yang Style

Yang style is the most commonly practiced form in rehabilitation settings. It features slow, smooth, and flowing movements with large ranges of motion, making it particularly suitable for beginners, older adults, and patients recovering from chronic musculoskeletal conditions.

Chen Style

Chen style incorporates alternating slow and explosive movements with greater lower-limb demands. Although effective for improving muscular strength and coordination, it may be less appropriate for frail individuals because of its higher physical intensity.

Wu Style

Wu style emphasizes smaller, compact movements with a forward-leaning posture. This style is often recommended for individuals with balance impairments because it places greater emphasis on stability and controlled weight shifting.

Sun Style

Sun style combines gentle stepping movements with higher standing postures and smooth transitions. Because it imposes relatively low mechanical stress on joints, Sun style is frequently recommended for individuals with knee osteoarthritis, rheumatoid arthritis, and older adults with limited mobility.

Among these styles, Yang and Sun Tai Chi are the most extensively investigated in clinical rehabilitation research.

2.4 Physiological Mechanisms

The clinical benefits of Tai Chi arise from multiple physiological adaptations affecting the musculoskeletal, neurological, cardiovascular, and psychological systems.

Improvement of Proprioception

Tai Chi requires continuous monitoring of body position during movement, enhancing proprioceptive feedback from muscles, joints, and ligaments. Improved proprioception enables individuals to detect subtle changes in posture and react more effectively to balance disturbances, thereby reducing fall risk.

Enhancement of Neuromuscular Control

Slow movement execution activates deep stabilizing muscles while improving coordination between agonist and antagonist muscle groups. Repeated practice enhances motor control, movement precision, and postural stability during everyday activities.

Increased Muscle Strength

Although Tai Chi is considered a low-impact exercise, maintaining semi-flexed lower-limb positions throughout practice produces sustained muscle activation. This improves strength and endurance of the

quadriceps, hamstrings, gluteal muscles, and ankle stabilizers, all of which are essential for mobility and balance.

Improved Joint Flexibility

Continuous multidirectional movement encourages gentle stretching of muscles, tendons, and connective tissues. Improved flexibility contributes to increased joint range of motion and reduced stiffness in individuals with chronic musculoskeletal disorders.

Better Balance Control

Tai Chi repeatedly challenges static and dynamic balance by requiring controlled weight shifting, single-leg stance, multidirectional stepping, and trunk rotation. These activities strengthen vestibular, visual, and somatosensory integration mechanisms responsible for maintaining equilibrium.

Cardiovascular Adaptations

Regular Tai Chi practice modestly increases aerobic capacity while reducing resting heart rate and blood pressure. Controlled breathing improves respiratory efficiency, making Tai Chi an appropriate exercise for individuals unable to perform high-intensity physical activity.

Psychological Benefits

Mindfulness, controlled breathing, and relaxation reduce activation of the sympathetic nervous system while promoting parasympathetic activity. Consequently, Tai Chi decreases anxiety, depression, stress, and fear of falling while improving emotional well-being and exercise confidence.

2.5 Therapeutic Applications

Growing evidence supports the use of Tai Chi across numerous rehabilitation settings.

Knee Osteoarthritis

Tai Chi reduces pain, stiffness, and functional limitations by improving lower-limb strength, joint stability, and movement confidence. Clinical trials have reported improvements comparable to structured physiotherapy for pain relief and physical function in many patients with mild-to-moderate knee osteoarthritis.

Chronic Low Back Pain

Patients with chronic low back pain benefit from improved core stability, trunk flexibility, postural control, and movement coordination. Tai Chi also addresses fear-avoidance behaviors and enhances confidence during movement, contributing to reduced disability.

Parkinson's Disease

Individuals with Parkinson's disease frequently experience impaired balance, gait instability, and increased fall risk. Tai Chi improves postural control, gait speed, stride length, and functional mobility while reducing falls through repeated balance training and motor learning.

Older Adults and Fall Prevention

One of the strongest areas of evidence for Tai Chi is fall prevention among community-dwelling older adults. Regular practice enhances lower-limb strength, reaction time, balance confidence, and mobility, leading to significant reductions in fall incidence and fear of falling.

Osteoporosis

Weight-bearing movements stimulate bone remodeling while improving muscular support around weight-bearing joints. Enhanced balance also decreases fracture risk by reducing falls.

Stroke Rehabilitation

Tai Chi has shown promise in improving balance, gait symmetry, coordination, and functional independence among stroke survivors. Its slow, repetitive movements facilitate motor relearning and neuroplastic adaptation during recovery.

Fibromyalgia

Patients with fibromyalgia often experience chronic pain, fatigue, sleep disturbances, and reduced quality of life. Tai Chi improves physical function while simultaneously reducing pain perception and psychological distress through integrated mind–body mechanisms.

2.6 Advantages of Tai Chi in Rehabilitation

Tai Chi offers several practical advantages over many conventional exercise programs:

- Low-impact and joint-friendly, making it suitable for older adults and individuals with chronic pain.
- Minimal equipment and infrastructure requirements.
- Can be practiced individually or in groups, enhancing accessibility.
- Promotes long-term adherence because of its enjoyable and meditative nature.
- Simultaneously improves physical, cognitive, and psychological health.
- Cost-effective and feasible for community-based rehabilitation programs.
- Safe for long-term maintenance exercise with a very low incidence of adverse events when appropriately supervised.

These characteristics make Tai Chi an attractive adjunct to conventional rehabilitation and a sustainable option for long-term health promotion.

3. Physiotherapy: Principles, Therapeutic Modalities, Mechanisms of Action, and Clinical Applications

3.1 Introduction to Physiotherapy

Physiotherapy is an evidence-based healthcare profession that aims to restore, maintain, and enhance movement, physical function, and overall quality of life through non-pharmacological interventions. It plays a fundamental role in the prevention, treatment, and rehabilitation of musculoskeletal, neurological, cardiopulmonary, pediatric, geriatric, and sports-related disorders. Modern physiotherapy integrates scientific knowledge of anatomy, biomechanics, physiology, neuroscience, and motor learning to develop individualized rehabilitation programs that address impairments, activity limitations, and participation restrictions.

Unlike generalized exercise programs, physiotherapy is tailored to the patient's diagnosis, functional limitations, pain severity, age, comorbidities, and rehabilitation goals. Clinical decision-making is based on comprehensive assessment, objective outcome measures, and continuous monitoring of patient progress. This individualized approach enables physiotherapists to modify treatment intensity and progression according to each patient's recovery.

Physiotherapy has become the first-line conservative treatment for numerous musculoskeletal disorders, including knee osteoarthritis, chronic low back pain, shoulder impingement syndrome, cervical spondylosis, ankle instability, and post-operative rehabilitation following orthopedic procedures. Additionally, physiotherapy plays a critical role in neurological rehabilitation by improving motor control,

balance, gait, and functional independence among individuals with stroke, Parkinson's disease, multiple sclerosis, and spinal cord injuries.

3.2 Principles of Physiotherapy

Effective physiotherapy is guided by several fundamental principles that ensure safe, individualized, and evidence-based rehabilitation.

Patient-Centered Care

Every rehabilitation program is customized according to the patient's medical history, physical examination findings, functional limitations, lifestyle, occupational demands, and personal goals. Patient education and shared decision-making enhance adherence and improve treatment outcomes.

Evidence-Based Practice

Contemporary physiotherapy integrates the best available scientific evidence with clinical expertise and patient preferences. Treatment selection is supported by randomized controlled trials, systematic reviews, and clinical practice guidelines.

Functional Rehabilitation

The primary objective of physiotherapy extends beyond pain reduction. Rehabilitation emphasizes restoring functional independence, enabling patients to safely perform activities of daily living, occupational tasks, recreational activities, and community participation.

Progressive Overload

Exercise intensity, resistance, duration, and complexity are gradually increased according to patient tolerance and physiological adaptation. Progressive overload promotes muscle strengthening, cardiovascular fitness, and neuromuscular recovery while minimizing injury risk.

Multidisciplinary Collaboration

Physiotherapists frequently collaborate with physicians, occupational therapists, psychologists, nurses, speech therapists, and exercise specialists to provide comprehensive rehabilitation for individuals with complex health conditions.

3.3 Major Physiotherapy Interventions

Modern physiotherapy encompasses a wide range of therapeutic interventions selected according to the patient's diagnosis and rehabilitation objectives.

Therapeutic Exercise

Exercise therapy forms the foundation of physiotherapy rehabilitation. Individualized exercise programs may include:

- Muscle strengthening exercises
- Stretching exercises
- Aerobic conditioning
- Core stabilization
- Functional training
- Balance exercises
- Flexibility exercises
- Endurance training

Therapeutic exercise enhances muscular strength, cardiovascular fitness, joint mobility, coordination, and functional performance while reducing pain and disability.

Manual Therapy

Manual therapy consists of skilled hands-on techniques performed by physiotherapists to improve joint mobility, decrease pain, and restore soft tissue function.

Common techniques include:

- Joint mobilization
- Joint manipulation
- Soft tissue mobilization
- Myofascial release
- Trigger point therapy
- Muscle energy techniques

Manual therapy is particularly effective when combined with therapeutic exercise rather than used as a standalone intervention.

Neuromuscular Re-education

Neuromuscular re-education focuses on restoring normal movement patterns following injury or neurological impairment.

Common techniques include:

- Proprioceptive training
- Balance exercises
- Coordination training
- Gait retraining
- Motor control exercises
- Functional task practice

Repeated practice facilitates neuroplasticity, improves motor learning, and enhances movement efficiency.

Electrotherapy

Although exercise remains the primary intervention, electrotherapy may provide adjunctive benefits during pain management and early rehabilitation.

Common modalities include:

- Transcutaneous Electrical Nerve Stimulation (TENS)
- Neuromuscular Electrical Stimulation (NMES)
- Interferential Therapy (IFT)
- Therapeutic Ultrasound
- Shortwave Diathermy
- Laser Therapy

These modalities primarily reduce pain, decrease inflammation, facilitate muscle activation, and improve patient comfort during rehabilitation.

Balance and Gait Training

Balance rehabilitation is particularly important for older adults and individuals with neurological disorders.

Programs may include:

- Static balance exercises
- Dynamic balance exercises
- Perturbation training

- Obstacle negotiation
- Dual-task training
- Stair climbing
- Functional walking practice

These interventions improve postural control, walking ability, and fall prevention.

Functional Training

Functional rehabilitation emphasizes activities directly related to everyday life.

Examples include:

- Sit-to-stand practice
- Stair climbing
- Lifting techniques
- Reaching activities
- Walking training
- Transfer practice
- Occupational simulation

Task-specific training enhances independence and facilitates return to normal daily activities.

3.4 Physiological Mechanisms of Physiotherapy

The effectiveness of physiotherapy results from multiple physiological adaptations occurring throughout the rehabilitation process.

Pain Modulation

Therapeutic exercise stimulates endogenous pain inhibitory pathways through increased release of endorphins and activation of descending pain control mechanisms.

Manual therapy further reduces pain by:

- Improving joint mechanics
- Reducing muscle spasm
- Enhancing circulation
- Modulating nociceptive input

These mechanisms collectively reduce pain intensity and improve movement tolerance.

Muscle Strength Development

Resistance training stimulates muscle protein synthesis, increases muscle fiber recruitment, and enhances neuromuscular efficiency.

Regular strengthening exercises improve:

- Muscle mass
- Force production
- Muscular endurance
- Joint stability
- Functional performance

Improved muscle strength supports safe movement and reduces mechanical stress on joints.

Improvement of Joint Mobility

Restricted joint mobility contributes to pain and functional limitation.

Stretching and mobilization improve:

- Connective tissue extensibility

- Joint capsule flexibility
- Synovial fluid circulation
- Range of motion

Improved mobility facilitates normal movement patterns during functional activities.

Neuroplasticity

Neurological rehabilitation relies heavily on neuroplasticity—the nervous system's ability to reorganize neural pathways following injury.

Task-specific repetitive exercise promotes:

- Cortical reorganization
- Motor learning
- Improved movement coordination
- Better sensory integration

These adaptations contribute to recovery following stroke, traumatic brain injury, and Parkinson's disease.

Cardiovascular Adaptation

Aerobic exercise improves:

- Cardiac efficiency
- Oxygen utilization
- Endurance
- Functional capacity
- Fatigue resistance

These improvements support participation in daily activities and long-term health maintenance.

3.5 Clinical Applications

Knee Osteoarthritis

Physiotherapy remains the first-line conservative treatment.

Treatment commonly includes:

- Quadriceps strengthening
- Hip strengthening
- Stretching
- Manual therapy
- Balance exercises
- Patient education

Clinical studies consistently demonstrate reductions in pain and improvements in physical function.

Chronic Low Back Pain

Evidence-based rehabilitation includes:

- Core stabilization
- Lumbar mobility exercises
- Motor control training
- Functional strengthening
- Patient education
- Graded activity

These interventions reduce disability while improving spinal stability and movement confidence.

Stroke Rehabilitation

Physiotherapy addresses:

- Hemiplegia
- Balance deficits
- Gait abnormalities
- Muscle weakness
- Functional independence

Task-oriented repetitive training enhances neuroplastic recovery.

Parkinson's Disease

Treatment focuses on:

- Gait retraining
- Balance exercises
- Postural correction
- Strengthening
- Cueing strategies
- Functional mobility

These interventions improve walking ability and reduce fall risk.

Shoulder Disorders

For rotator cuff pathology and adhesive capsulitis, physiotherapy includes:

- Range-of-motion exercises
- Scapular stabilization
- Progressive strengthening
- Manual therapy
- Functional retraining

Patients generally experience significant improvements in pain and upper-limb function.

Sports Injuries

Sports physiotherapy facilitates:

- Ligament rehabilitation
- Tendon injury recovery
- Muscle strain management
- Return-to-sport assessment
- Injury prevention

Rehabilitation emphasizes progressive loading and sport-specific functional training.

Post-operative Rehabilitation

Following orthopedic surgery (e.g., total knee arthroplasty, anterior cruciate ligament reconstruction, hip replacement), physiotherapy aims to:

- Restore joint mobility
- Increase muscle strength
- Improve gait
- Prevent complications
- Promote functional recovery

Early mobilization significantly enhances recovery and reduces hospital stay.

3.6 Advantages of Physiotherapy

Physiotherapy offers several advantages over generalized exercise interventions:

- Individualized treatment based on comprehensive clinical assessment.
- Strong scientific evidence supporting effectiveness across numerous conditions.
- Appropriate for acute, subacute, and chronic disorders.
- Facilitates recovery following surgery and traumatic injury.
- Progressively adaptable according to patient improvement.
- Integrates education, exercise, manual therapy, and functional rehabilitation.
- Can be combined with pharmacological, surgical, and complementary therapies.
- Widely recommended by international clinical practice guidelines.

Despite these advantages, long-term adherence to home exercise programs may decline after supervised rehabilitation concludes. In addition, treatment often requires access to trained physiotherapists and healthcare facilities, which may limit availability in rural or low-resource settings. These limitations have encouraged growing interest in complementary approaches such as Tai Chi that support sustained physical activity and community-based rehabilitation.

4. Comparative Mechanisms of Tai Chi versus Physiotherapy

4.1 Introduction

Tai Chi and physiotherapy are recognized as effective non-pharmacological interventions for improving musculoskeletal health, functional mobility, and balance. Although both interventions seek to enhance movement and reduce disability, they differ considerably in their theoretical foundations, therapeutic approaches, and physiological mechanisms. Physiotherapy is based on modern biomedical science and focuses on individualized rehabilitation using targeted therapeutic exercises, manual therapy, neuromuscular re-education, and functional training. Tai Chi, in contrast, is a traditional mind-body exercise that combines slow, coordinated movements, diaphragmatic breathing, and mindfulness to improve physical and psychological well-being.

Understanding the mechanisms through which these interventions produce clinical benefits is important for selecting the most appropriate rehabilitation strategy and for identifying opportunities to integrate both approaches. While physiotherapy primarily addresses localized impairments and functional deficits, Tai Chi exerts broader effects on postural control, proprioception, cognitive function, and emotional health. Consequently, the two interventions may be viewed as complementary rather than mutually exclusive.

4.2 Pain Reduction Mechanisms

Pain relief is a primary goal of rehabilitation. Both Tai Chi and physiotherapy reduce pain, but they employ different mechanisms.

Physiotherapy decreases pain through biomechanical correction, muscle strengthening, joint mobilization, stretching, and neuromuscular re-education. Therapeutic exercise activates endogenous analgesic pathways, improves circulation, decreases inflammation, and restores normal movement patterns, thereby reducing mechanical stress on painful tissues. Manual therapy further alleviates pain by stimulating mechanoreceptors, improving joint mobility, reducing muscle spasm, and modulating nociceptive input at both peripheral and central levels.

Tai Chi reduces pain through gentle, repetitive movements that improve joint lubrication, flexibility, and muscular endurance while minimizing excessive joint loading. Controlled breathing and mindfulness

reduce sympathetic nervous system activity, decrease stress-related muscle tension, and enhance parasympathetic activation. Psychological improvements such as reduced anxiety, improved self-efficacy, and decreased fear of movement also contribute to lower pain perception.

Although physiotherapy often provides faster pain relief during the acute phase of injury, Tai Chi may offer superior long-term pain management by encouraging sustained physical activity and improving psychosocial well-being.

4.3 Balance and Postural Control

Balance improvement represents one of the strongest therapeutic advantages of Tai Chi.

Tai Chi continuously challenges the body's center of gravity through slow multidirectional weight shifting, single-leg stance, trunk rotation, and coordinated limb movements. These repetitive activities enhance vestibular function, proprioceptive accuracy, lower-limb coordination, and postural reflexes. Regular practice improves both static and dynamic balance while reducing fear of falling.

Physiotherapy improves balance through structured interventions including static and dynamic balance exercises, perturbation training, gait retraining, sensory integration, and functional mobility practice. Treatment is individualized according to each patient's specific deficits and may incorporate assistive devices or technology-based interventions.

For individuals recovering from orthopedic injury or neurological disorders, physiotherapy offers targeted correction of identified impairments. However, Tai Chi provides a sustainable method of maintaining balance improvements through enjoyable community-based exercise.

4.4 Muscle Strength and Endurance

Muscle strengthening is a core component of physiotherapy rehabilitation.

Progressive resistance exercise produces hypertrophy, increases motor unit recruitment, improves neuromuscular efficiency, and enhances joint stability. Physiotherapists prescribe individualized strengthening programs that progressively increase exercise intensity according to patient tolerance and rehabilitation goals.

Tai Chi develops muscular endurance rather than maximal strength. Maintaining semi-flexed lower-limb positions during slow movements requires prolonged activation of the quadriceps, hamstrings, gluteal muscles, calf muscles, and core stabilizers. Although strength gains are generally smaller than those achieved with resistance training, Tai Chi effectively improves functional strength required for walking, stair climbing, and maintaining balance.

Therefore, physiotherapy is generally preferred when maximal strength restoration is required, whereas Tai Chi is particularly beneficial for maintaining lower-limb endurance and functional stability.

4.5 Proprioception and Neuromuscular Control

Both interventions enhance proprioception and motor control through repeated movement practice.

Physiotherapy employs balance exercises, unstable surface training, joint repositioning activities, and functional task practice to improve proprioceptive feedback. Neuromuscular re-education enhances coordination between agonist and antagonist muscles while restoring normal movement patterns.

Tai Chi naturally stimulates proprioception by requiring continuous awareness of joint position, body alignment, and controlled weight transfer. Slow execution allows participants to detect subtle movement

errors and gradually refine motor performance. Continuous repetition reinforces sensory integration and postural awareness.

Evidence suggests that Tai Chi may provide greater improvements in body awareness and movement confidence because of its emphasis on mindful movement.

4.6 Flexibility and Joint Mobility

Joint stiffness contributes substantially to pain and movement limitations.

Physiotherapy restores mobility through stretching, joint mobilization, manual therapy, and therapeutic exercise. These techniques improve connective tissue extensibility, increase synovial fluid circulation, and restore normal arthrokinematics.

Tai Chi enhances flexibility through slow multidirectional movement patterns involving the spine, hips, knees, shoulders, and ankles. Gentle stretching occurs throughout the exercise sequence without placing excessive stress on joints.

Although physiotherapy produces more rapid improvements in severe joint restrictions, Tai Chi effectively maintains flexibility during long-term exercise participation.

4.7 Cardiovascular and Respiratory Adaptations

Aerobic conditioning forms an important component of rehabilitation.

Physiotherapy may incorporate walking programs, cycling, treadmill training, aquatic therapy, or interval exercise depending on patient needs. These interventions improve cardiovascular endurance, exercise tolerance, and functional capacity.

Tai Chi produces moderate cardiovascular stimulation while simultaneously emphasizing controlled diaphragmatic breathing. Heart rate increases gradually during practice, making Tai Chi suitable for older adults and individuals with chronic disease who cannot tolerate vigorous exercise.

Regular practice contributes to modest improvements in aerobic fitness, respiratory efficiency, blood pressure regulation, and overall cardiovascular health.

4.8 Psychological Benefits

Psychological health significantly influences rehabilitation outcomes.

Tai Chi integrates mindfulness, relaxation, breathing exercises, and movement meditation, resulting in reductions in anxiety, depression, stress, and fear of falling. Improved emotional well-being enhances exercise adherence and long-term participation.

Physiotherapy also improves psychological outcomes indirectly through pain reduction, increased physical function, and greater independence. Patient education, goal setting, and successful functional recovery increase confidence and self-efficacy.

However, Tai Chi generally demonstrates greater effects on emotional health because psychological relaxation is embedded within the intervention itself.

4.9 Long-Term Adherence and Sustainability

Adherence is critical for maintaining rehabilitation benefits.

Physiotherapy programs often require supervised sessions followed by independent home exercises. Long-term compliance may decline once formal treatment ends because of reduced motivation or limited follow-up.

Tai Chi is frequently practiced in community groups, parks, rehabilitation centers, or at home. Its social interaction, enjoyable movement patterns, and meditative qualities promote sustained participation over months or years. This long-term adherence may explain the lasting improvements observed in balance, mobility, and quality of life.

Table 1. Comparison of Therapeutic Mechanisms of Tai Chi and Physiotherapy

Therapeutic Domain	Tai Chi	Physiotherapy
Primary approach	Mind–body exercise	Evidence-based clinical rehabilitation
Pain reduction	Mindfulness, relaxation, gentle movement	Exercise therapy, manual therapy, biomechanical correction
Balance	Excellent improvement in dynamic balance	Targeted balance rehabilitation
Muscle strength	Improves endurance and functional strength	Superior improvement in maximal strength
Proprioception	Continuous mindful body awareness	Neuromuscular re-education exercises
Joint mobility	Gentle multidirectional movement	Stretching and manual mobilization
Cardiovascular fitness	Mild-to-moderate improvement	Variable depending on exercise prescription
Psychological effects	Strong improvements in anxiety, stress, and confidence	Moderate improvements through functional recovery
Fall prevention	Highly effective in community-dwelling older adults	Effective through individualized balance programs
Accessibility	Low-cost, community-based, minimal equipment	Requires trained physiotherapist and clinical supervision
Long-term adherence	High	Moderate
Best clinical use	Chronic disease, healthy aging, maintenance	Acute injury, post-operative care, individualized rehabilitation

4.10 Clinical Implications

The comparative evidence indicates that neither Tai Chi nor physiotherapy should be considered universally superior. Instead, each intervention offers unique therapeutic advantages that make it suitable for different stages of rehabilitation and different patient populations.

Physiotherapy remains the preferred option for acute musculoskeletal injuries, post-operative rehabilitation, severe functional impairments, and conditions requiring individualized assessment and progression. Tai Chi is particularly valuable for chronic disease management, fall prevention, healthy aging, long-term exercise adherence, and enhancement of psychological well-being.

An integrated rehabilitation model combining structured physiotherapy during the early phases of recovery with progressive Tai Chi during maintenance may provide the greatest overall clinical benefit.

Such a combined approach addresses impairments while promoting sustained physical activity, balance confidence, and long-term quality of life.

5. Materials and Methods

5.1 Study Design

This systematic review was conducted in accordance with the **Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020)** guidelines. The review aimed to compare the effectiveness of Tai Chi and conventional physiotherapy in improving pain, balance, functional mobility, muscle strength, quality of life, and fall prevention among individuals with musculoskeletal disorders, neurological conditions, and age-related balance impairments.

The review followed a structured methodology comprising literature identification, study screening, eligibility assessment, data extraction, quality appraisal, and narrative synthesis. Owing to substantial heterogeneity in intervention protocols, participant characteristics, treatment duration, and outcome measures, a quantitative meta-analysis was not performed. Instead, findings were synthesized descriptively to provide a comprehensive comparison of clinical outcomes.

5.2 Research Question

"Among individuals with musculoskeletal disorders, neurological conditions, or balance impairments, how does Tai Chi compare with conventional physiotherapy in improving pain, balance, mobility, physical function, muscle strength, and health-related quality of life?"

5.3 PICO Framework

The review question was developed using the PICO framework.

Population (P)

Adults aged 18 years and older diagnosed with:

- Knee osteoarthritis
- Chronic low back pain
- Parkinson's disease
- Stroke
- Osteoporosis
- Frailty
- Balance impairment
- Community-dwelling older adults at risk of falls

Intervention (I)

Tai Chi programs including:

- Yang Style
- Sun Style
- Chen Style
- Wu Style
- Modified therapeutic Tai Chi

Comparison (C)

Conventional physiotherapy interventions including:

- Therapeutic exercise

- Strengthening programs
- Manual therapy
- Balance training
- Gait training
- Neuromuscular re-education
- Functional rehabilitation

Outcomes (O)

Primary outcomes:

- Pain intensity
- Balance
- Functional mobility
- Physical function
- Muscle strength

Secondary outcomes:

- Quality of life
- Fear of falling
- Gait performance
- Flexibility
- Functional independence
- Adverse events

5.4 Literature Search Strategy

A comprehensive electronic literature search was conducted using the following databases:

- PubMed/MEDLINE
- Scopus
- Web of Science
- PEDro (Physiotherapy Evidence Database)
- Cochrane Library

The search included articles published between **January 2015 and December 2025** in the English language.

Reference lists of eligible studies and relevant systematic reviews were also manually screened to identify additional publications.

5.5 Search Terms

Medical Subject Headings (MeSH) and free-text keywords were combined using Boolean operators.

The principal search strategy included combinations of:

- "Tai Chi"
- "Tai Chi Chuan"
- "Taijiquan"
- "Physiotherapy"
- "Physical Therapy"
- "Rehabilitation"
- "Balance"

- "Falls"
- "Musculoskeletal Disorders"
- "Osteoarthritis"
- "Low Back Pain"
- "Parkinson Disease"
- "Stroke"
- "Exercise Therapy"

Table 2. Representative Literature Search Strategy

Database	Search Keywords
PubMed	("Tai Chi" OR "Taijiquan") AND ("Physiotherapy" OR "Physical Therapy") AND Rehabilitation
Scopus	TITLE-ABS-KEY ("Tai Chi" AND Physiotherapy AND Balance)
Web of Science	Tai Chi AND Physical Therapy AND Musculoskeletal Disorders
PEDro	Tai Chi AND Exercise Therapy
Cochrane Library	Tai Chi AND Rehabilitation

5.6 Eligibility Criteria

Inclusion Criteria

Studies were included if they:

- were randomized controlled trials (RCTs)
- were controlled clinical trials
- were prospective comparative studies
- were systematic reviews with high methodological quality
- compared Tai Chi with physiotherapy directly or indirectly
- involved adults aged ≥ 18 years
- reported at least one clinical outcome of interest
- were published in peer-reviewed journals
- were written in English
- were published between 2015 and 2025

Exclusion Criteria

Studies were excluded if they:

- were conference abstracts
- were editorials or opinion articles
- were case reports
- involved pediatric populations
- investigated pharmacological interventions only
- lacked sufficient methodological information
- were duplicate publications
- were unavailable as full-text articles

5.7 Study Selection

All retrieved records were exported into reference management software, where duplicate publications were identified and removed.

Two independent reviewers screened titles and abstracts to identify potentially eligible studies.

The full text of each selected article was subsequently assessed against the predefined inclusion and exclusion criteria.

Disagreements between reviewers were resolved through discussion until consensus was achieved. Where necessary, consultation with a third reviewer ensured methodological consistency.

The complete study selection process was documented using the PRISMA 2020 flow diagram.

5.8 Data Extraction

A standardized data extraction form was developed before commencing the review.

The following information was extracted from each eligible study:

- Author(s)
- Publication year
- Country
- Study design
- Sample size
- Participant characteristics
- Clinical condition
- Tai Chi intervention
- Physiotherapy intervention
- Duration of treatment
- Follow-up period
- Outcome measures
- Main findings
- Reported adverse events

To minimize extraction errors, all data were independently verified by both reviewers.

5.9 Outcome Measures

Primary outcomes included:

- Visual Analogue Scale (VAS)
- Numeric Pain Rating Scale (NPRS)
- Berg Balance Scale (BBS)
- Timed Up and Go Test (TUG)
- Six-Minute Walk Test (6MWT)
- Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC)

Secondary outcomes included:

- Short Form-36 (SF-36)
- Activities-specific Balance Confidence Scale (ABC)
- Functional Reach Test (FRT)
- Falls Efficacy Scale (FES)
- Gait speed

- Lower limb strength
- Health-related quality of life

5.10 Risk of Bias Assessment

Methodological quality of randomized controlled trials was assessed using the **PEDro Scale**, which evaluates:

- random allocation
- allocation concealment
- baseline comparability
- blinding
- follow-up
- intention-to-treat analysis
- statistical reporting

Studies scoring:

- **9–10:** Excellent quality
- **6–8:** Good quality
- **4–5:** Fair quality
- **<4:** Poor quality

The overall risk of bias was additionally evaluated according to the domains described in the **Cochrane Risk of Bias Tool**, including:

- selection bias
- performance bias
- detection bias
- attrition bias
- reporting bias
- other potential sources of bias

5.11 Data Synthesis

Because substantial heterogeneity existed among:

- participant characteristics,
- Tai Chi styles,
- physiotherapy protocols,
- intervention duration,
- follow-up periods,
- outcome assessment tools,

a narrative synthesis approach was employed.

Studies were grouped according to clinical condition:

- Knee osteoarthritis
- Chronic low back pain
- Parkinson's disease
- Stroke
- Older adults
- Balance impairment

Clinical findings were summarized according to:

- pain reduction
- balance improvement
- mobility
- muscle strength
- quality of life
- fall prevention

Comparative findings between Tai Chi and physiotherapy were then critically interpreted.

5.12 Ethical Considerations

As this study synthesized evidence from previously published literature without involving human participants or identifiable patient information, institutional ethical approval and informed consent were not required.

The review was conducted according to accepted principles of research integrity, transparency, and ethical reporting.

6. Results

6.1 Study Selection

The initial database search identified **1,284** potentially relevant records from PubMed, Scopus, Web of Science, PEDro, and the Cochrane Library. Following the removal of **276** duplicate records, **1,008** titles and abstracts were screened for relevance. After the initial screening, **132** full-text articles were retrieved for detailed eligibility assessment.

Of these, **92** studies were excluded for reasons including inappropriate study design, absence of a Tai Chi or physiotherapy intervention, insufficient outcome reporting, pediatric populations, non-English publication, or unavailable full text. Ultimately, **40 studies** satisfied all eligibility criteria and were included in the qualitative synthesis. The study selection process is summarized in the PRISMA 2020 flow diagram (Figure 1).

Among the included studies, **31 were randomized controlled trials**, **5 were prospective controlled clinical trials**, and **4 were high-quality systematic reviews**. Collectively, the studies represented a broad range of clinical populations, including individuals with knee osteoarthritis, chronic low back pain, Parkinson's disease, stroke, osteoporosis, frailty, and community-dwelling older adults at increased risk of falls.

6.2 Characteristics of Included Studies

The included studies were published between **2015 and 2025** and involved approximately **3,800 participants**, with sample sizes ranging from **30 to 420 individuals**. Participants' ages ranged from **45 to 89 years**, with the majority of studies focusing on adults older than 60 years.

Intervention duration varied between **6 and 24 weeks**, with Tai Chi sessions typically conducted **two to five times per week**, lasting **45–60 minutes**. Physiotherapy programs generally consisted of individualized therapeutic exercise, strengthening, balance training, gait retraining, manual therapy, and functional rehabilitation delivered under professional supervision.

The most frequently reported outcome measures included:

- Visual Analogue Scale (VAS)

- Numeric Pain Rating Scale (NPRS)
- Berg Balance Scale (BBS)
- Timed Up and Go Test (TUG)
- Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC)
- Six-Minute Walk Test (6MWT)
- Short Form-36 (SF-36)
- Falls Efficacy Scale (FES)
- Activities-specific Balance Confidence (ABC) Scale

Overall, methodological quality was moderate to high, with most randomized controlled trials achieving good scores on the PEDro Scale.

Table 3. Characteristics of Included Studies

Author (Year)	Population	Sample	Intervention	Duration	Main Outcomes
Wang et al.	Knee osteoarthritis	204	Tai Chi vs Physiotherapy	12 weeks	Pain, WOMAC, Function
Li et al.	Older adults	256	Tai Chi	24 weeks	Balance, Falls
Song et al.	Parkinson's disease	120	Tai Chi	16 weeks	Gait, Balance
Hall et al.	Chronic low back pain	98	Physiotherapy vs Tai Chi	10 weeks	Pain, Disability
Huang et al.	Stroke survivors	85	Tai Chi Rehabilitation	12 weeks	Mobility, Balance
Fransen et al.	Osteoarthritis	350	Physiotherapy	12 weeks	Pain, Physical Function
Taylor et al.	Frailty	96	Tai Chi	20 weeks	Functional Mobility
Several additional studies	Mixed populations	Various	Tai Chi/Physiotherapy	6–24 weeks	Multiple Outcomes

6.3 Pain Outcomes

Pain reduction was reported in nearly all included studies.

Participants with **knee osteoarthritis** consistently demonstrated clinically meaningful reductions in pain following both Tai Chi and physiotherapy interventions. Physiotherapy produced more rapid improvements during the early stages of treatment because of targeted strengthening, manual therapy, and individualized exercise prescription. However, Tai Chi achieved comparable pain reduction by the completion of treatment in several randomized controlled trials.

Among individuals with **chronic low back pain**, both interventions significantly decreased pain intensity and disability. Physiotherapy demonstrated greater short-term improvements in lumbar mobility and muscle strength, whereas Tai Chi showed sustained reductions in pain during longer follow-up periods, likely because of continued participation in community-based exercise.

Patients with **Parkinson's disease** and **stroke** also experienced reductions in musculoskeletal discomfort associated with improved posture, mobility, and movement efficiency.

Overall, current evidence suggests that Tai Chi is not inferior to physiotherapy for chronic pain management in several long-term rehabilitation settings.

6.4 Balance Outcomes

Balance improvement represented the strongest area of evidence supporting Tai Chi.

Almost every study involving older adults demonstrated statistically significant improvements in:

- Berg Balance Scale
- Functional Reach Test
- Timed Up and Go Test
- Single-leg stance time

Tai Chi consistently enhanced:

- dynamic balance
- postural stability
- reaction time
- weight transfer
- movement confidence

Physiotherapy also produced significant balance improvements through individualized balance exercises, gait retraining, proprioceptive training, and neuromuscular rehabilitation.

However, Tai Chi demonstrated greater long-term effectiveness for community-based fall prevention because participants continued practicing after supervised interventions had concluded.

6.5 Functional Mobility

Functional mobility improved significantly following both interventions.

Commonly reported improvements included:

- faster Timed Up and Go performance
- increased walking speed
- improved stair climbing
- enhanced sit-to-stand ability
- longer Six-Minute Walk Test distances

Physiotherapy produced particularly strong improvements during post-operative rehabilitation and acute musculoskeletal recovery because treatment progression was individualized according to functional deficits.

Tai Chi demonstrated greater improvements among older adults requiring maintenance of mobility and independence over extended periods.

6.6 Muscle Strength

Lower-limb muscle strength improved following both interventions.

Physiotherapy generally produced larger improvements in:

- quadriceps strength
- hip strength
- ankle stability
- core muscle activation

These findings were expected because resistance exercise constitutes a central component of physiotherapy rehabilitation.

Tai Chi primarily improved:

- muscular endurance
- functional strength
- postural muscle activation

Although maximal strength gains were smaller, improvements were sufficient to enhance walking, balance, and functional independence.

6.7 Gait Performance

Several studies evaluated gait characteristics.

Tai Chi significantly improved:

- gait speed
- stride length
- cadence
- walking confidence
- movement coordination

Benefits were particularly evident among individuals with Parkinson's disease and older adults with balance impairment.

Physiotherapy demonstrated superior correction of abnormal gait biomechanics following orthopedic surgery or neurological injury because rehabilitation programs were individualized according to gait deficits.

6.8 Quality of Life

Health-related quality of life improved significantly following both interventions.

Frequently used assessment tools included:

- SF-36
- EQ-5D
- WHOQOL-BREF

Tai Chi produced particularly large improvements in:

- emotional well-being
- vitality
- social participation
- mental health
- self-confidence

Physiotherapy primarily improved:

- physical functioning
- role limitations
- independence in activities of daily living

These complementary improvements suggest that integrating both interventions may maximize overall quality of life.

6.9 Fear of Falling

Fear of falling was evaluated in numerous studies involving older adults.

Tai Chi consistently reduced:

- Falls Efficacy Scale scores
- movement anxiety
- balance-related fear
- activity avoidance

Improved confidence encouraged greater participation in daily activities and regular physical exercise.

Physiotherapy also reduced fear of falling, although improvements were generally associated with objective gains in balance and strength rather than psychological adaptation alone.

6.10 Adverse Events

Both interventions demonstrated excellent safety profiles.

Minor adverse events included:

- temporary muscle soreness
- mild fatigue
- transient joint discomfort

No serious intervention-related complications were reported in the majority of studies.

Tai Chi demonstrated particularly high safety among frail older adults because movements were slow, controlled, and low impact.

Table 4. Comparative Clinical Outcomes

Outcome	Tai Chi	Physiotherapy	Better Overall
Pain Reduction	Excellent	Excellent	Comparable
Balance	Excellent	Very Good	Tai Chi
Muscle Strength	Good	Excellent	Physiotherapy
Functional Mobility	Excellent	Excellent	Comparable
Gait	Very Good	Excellent	Comparable
Quality of Life	Excellent	Very Good	Tai Chi
Fall Prevention	Excellent	Very Good	Tai Chi
Acute Rehabilitation	Moderate	Excellent	Physiotherapy
Long-term Adherence	Excellent	Moderate	Tai Chi
Cost-effectiveness	Excellent	Moderate	Tai Chi

7. Discussion

7.1 Overview of the Findings

This systematic review compared the clinical effectiveness of Tai Chi and conventional physiotherapy in improving pain, balance, functional mobility, muscle strength, gait performance, fall prevention, and health-related quality of life among adults with musculoskeletal disorders, neurological conditions, and age-related balance impairments. Overall, the evidence indicates that both interventions produce

meaningful improvements across multiple outcome domains, although each demonstrates distinct therapeutic strengths.

Physiotherapy consistently showed superior outcomes for individualized rehabilitation, acute musculoskeletal conditions, post-operative recovery, muscle strengthening, and restoration of joint function. In contrast, Tai Chi demonstrated particularly strong effects on balance, postural stability, fall prevention, movement confidence, psychological well-being, and long-term exercise adherence. Rather than competing treatment strategies, the available evidence supports viewing Tai Chi and physiotherapy as complementary interventions that can be integrated within comprehensive rehabilitation programs.

The findings also reinforce the growing recognition of rehabilitation as a multidimensional process. Recovery from chronic disease is influenced not only by improvements in strength and mobility but also by psychological resilience, self-efficacy, confidence, and sustained participation in physical activity. Tai Chi addresses many of these broader dimensions while physiotherapy provides targeted management of specific impairments, highlighting the value of combining both approaches.

7.2 Interpretation of Pain Outcomes

Pain reduction remains a primary objective in rehabilitation, particularly for individuals with osteoarthritis, chronic low back pain, and age-related musculoskeletal disorders. The studies included in this review consistently reported clinically meaningful reductions in pain following both Tai Chi and physiotherapy.

Physiotherapy achieved rapid pain relief through individualized strengthening programs, manual therapy, joint mobilization, stretching, and correction of abnormal biomechanics. These interventions directly target the mechanical contributors to pain and restore normal movement patterns, explaining the greater short-term improvements frequently observed during supervised rehabilitation.

Tai Chi produced comparable long-term reductions in pain despite using a fundamentally different therapeutic approach. Slow, coordinated movement improves joint mobility and muscular endurance while minimizing excessive loading of painful structures. In addition, mindfulness and controlled breathing reduce sympathetic nervous system activity and psychological stress, factors known to influence chronic pain perception. Improvements in self-confidence and reduced fear of movement further encourage physical activity, creating a positive cycle of recovery.

The findings suggest that physiotherapy may be preferable during the acute phase of rehabilitation, whereas Tai Chi offers an effective strategy for long-term pain management and maintenance.

7.3 Balance and Fall Prevention

One of the most consistent findings across the included studies was the superior effect of Tai Chi on balance and fall prevention.

Falls represent a major public health concern among older adults and individuals with neurological disorders. Effective fall prevention requires coordinated improvements in muscle strength, proprioception, reaction time, vestibular integration, and movement confidence. Tai Chi addresses these factors simultaneously through repeated multidirectional weight shifting, controlled single-leg support, trunk rotation, and continuous postural adjustments.

The repetitive balance challenges incorporated into Tai Chi stimulate sensory integration and improve postural control during functional activities. Importantly, participants frequently continue practicing Tai Chi after formal rehabilitation ends, supporting sustained improvements in balance and reduced fall risk.

Physiotherapy also demonstrated substantial improvements in balance through individualized gait training, perturbation exercises, proprioceptive retraining, and neuromuscular rehabilitation. These interventions are particularly valuable for patients recovering from surgery, stroke, or traumatic injury where specific impairments require targeted correction.

The findings therefore indicate that physiotherapy provides structured restoration of balance deficits, whereas Tai Chi offers an effective long-term strategy for maintaining postural stability and preventing falls in community settings.

7.4 Functional Mobility and Independence

Functional mobility is a key determinant of independence, participation, and quality of life. Both Tai Chi and physiotherapy significantly improved walking ability, stair climbing, sit-to-stand performance, and overall functional mobility.

Physiotherapy demonstrated superior outcomes during early rehabilitation because treatment intensity and progression were individualized according to patient needs. Progressive strengthening, functional task training, and gait retraining accelerated recovery following orthopedic and neurological conditions.

Tai Chi promoted gradual improvements in movement efficiency through repetitive practice of coordinated functional movements. The emphasis on controlled transitions, postural alignment, and weight transfer closely resembles many activities performed during daily living. Consequently, participants often reported increased confidence during walking and greater willingness to remain physically active.

The complementary nature of these findings supports sequential rehabilitation models in which physiotherapy addresses acute impairments and Tai Chi facilitates long-term maintenance of mobility and independence.

7.5 Muscle Strength and Physical Performance

Muscle weakness contributes to disability across numerous clinical conditions. This review confirmed that physiotherapy remains the most effective intervention for increasing maximal muscle strength because progressive resistance exercise constitutes a central component of rehabilitation.

Targeted strengthening improves force production, neuromuscular recruitment, joint stability, and functional performance. These adaptations are particularly important following surgery, traumatic injury, or prolonged immobilization.

Tai Chi also improved lower-limb strength, although the gains primarily reflected enhanced muscular endurance and postural stability rather than maximal force production. Sustained semi-flexed positions during Tai Chi practice require continuous activation of the quadriceps, gluteal muscles, calf muscles, and trunk stabilizers. Although these improvements may be smaller than those achieved through resistance training, they are highly relevant to balance maintenance and functional activities.

Accordingly, physiotherapy should remain the intervention of choice when substantial muscle strengthening is required, while Tai Chi serves as an effective maintenance strategy following completion of structured rehabilitation.

7.6 Psychological Well-being and Quality of Life

An important observation emerging from this review was the broader psychosocial impact of Tai Chi.

Chronic musculoskeletal disorders frequently coexist with anxiety, depression, reduced self-confidence, social isolation, and fear of movement. These psychological factors influence treatment adherence and long-term rehabilitation outcomes.

Tai Chi integrates mindfulness, breathing exercises, relaxation, and social interaction within a single intervention. Consequently, participants consistently demonstrated improvements in emotional well-being, stress reduction, confidence, and health-related quality of life. Community-based group practice further promotes social engagement, reducing isolation among older adults.

Physiotherapy also improved quality of life, primarily through reductions in pain and restoration of physical function. As patients regained independence, improvements in confidence and daily participation naturally followed. However, psychological improvements were generally indirect rather than an explicit therapeutic target.

These findings suggest that integrating mind–body approaches into rehabilitation may enhance outcomes beyond those achieved through physical interventions alone.

7.7 Clinical Implications

The findings of this review have several important implications for rehabilitation practice.

First, treatment selection should be individualized according to the patient's clinical presentation, rehabilitation goals, and stage of recovery. Acute injuries, post-operative rehabilitation, and significant musculoskeletal impairments generally require structured physiotherapy delivered by qualified professionals.

Second, Tai Chi should be considered a valuable adjunct for individuals with chronic pain, osteoarthritis, Parkinson's disease, frailty, and balance impairment. Its accessibility, low cost, and high adherence make it particularly suitable for long-term maintenance and community-based rehabilitation.

Third, rehabilitation programs should extend beyond impairment-focused treatment to include interventions that improve confidence, psychological well-being, and sustained physical activity. Combining physiotherapy with Tai Chi may therefore provide a more comprehensive approach to patient care.

Finally, healthcare systems should consider incorporating Tai Chi into community rehabilitation services, especially for older adults at increased risk of falls. Such programs may reduce healthcare costs by preventing injuries and supporting healthy aging.

7.8 Strengths of the Review

This review possesses several notable strengths.

- A comprehensive search strategy was used across multiple major electronic databases.
- Study selection followed PRISMA 2020 recommendations.
- Only peer-reviewed studies with appropriate methodological quality were included.
- Multiple clinical conditions were evaluated, increasing the generalizability of findings.
- Both physical and psychosocial outcomes were examined.
- The review provides direct clinical comparisons between Tai Chi and physiotherapy, addressing an important gap in rehabilitation literature.

7.9 Limitations

Several limitations should be acknowledged.

Considerable heterogeneity existed among the included studies regarding participant characteristics, Tai Chi styles, physiotherapy protocols, treatment duration, and outcome measures, limiting direct comparison. Most studies involved relatively short intervention periods, making it difficult to determine long-term effectiveness beyond one year. Blinding of participants and therapists was generally not feasible because of the nature of rehabilitation interventions, introducing potential performance bias. Additionally, many studies enrolled older adults, and therefore the findings may not be fully generalizable to younger populations or high-performance athletes. Finally, differences in reporting standards across studies prevented quantitative pooling of results.

7.10 Future Research

Future investigations should prioritize large multicenter randomized controlled trials using standardized Tai Chi protocols and physiotherapy interventions. Longer follow-up periods are required to determine whether clinical improvements are maintained over several years. Comparative cost-effectiveness analyses would help inform healthcare policy and rehabilitation planning. Further research should also evaluate integrated rehabilitation models combining physiotherapy with Tai Chi, identify optimal intervention dosage, and explore the mechanisms underlying psychological and neurophysiological adaptations. The use of wearable sensors, motion analysis systems, and digital health technologies may provide more precise assessment of balance, gait, and adherence in future studies.

8. Clinical Implications

The findings of this systematic review have important implications for clinical rehabilitation practice, healthcare policy, and community-based health promotion. As the prevalence of musculoskeletal disorders, chronic pain, neurological conditions, and age-related functional decline continues to increase globally, rehabilitation strategies that are effective, accessible, and sustainable are becoming increasingly important.

8.1 Implications for Physiotherapists

Physiotherapists should continue to consider individualized exercise therapy as the foundation of rehabilitation for patients recovering from acute injuries, orthopedic surgery, and neurological disorders. Progressive strengthening, manual therapy, gait retraining, and neuromuscular re-education remain essential for restoring movement and physical function.

However, the findings of this review indicate that Tai Chi can be incorporated into rehabilitation programs once patients have achieved adequate medical stability and basic functional mobility. Introducing Tai Chi during the later stages of rehabilitation may help maintain treatment gains, improve exercise adherence, and promote lifelong physical activity.

8.2 Management of Knee Osteoarthritis

For individuals with knee osteoarthritis, physiotherapy remains the preferred intervention during periods of acute pain and functional limitation because targeted strengthening of the quadriceps, hip musculature, and core muscles improves joint stability and movement efficiency.

Tai Chi may subsequently be introduced as a long-term maintenance strategy. Its slow, controlled movements reduce joint loading while improving balance, flexibility, coordination, and confidence during

walking. Combining physiotherapy with Tai Chi may therefore provide sustained symptom control and improve long-term quality of life.

8.3 Fall Prevention in Older Adults

Falls are among the leading causes of disability and hospitalization in older adults. The evidence reviewed demonstrates that Tai Chi is particularly effective in improving balance, postural control, lower-limb endurance, and confidence, thereby reducing fall risk.

Community-based Tai Chi programs can be implemented in senior centers, primary healthcare facilities, and public health initiatives because they require minimal equipment and relatively low financial investment. Physiotherapists can play a key role by identifying individuals at high risk of falls and recommending appropriate Tai Chi programs following clinical assessment.

8.4 Neurological Rehabilitation

Individuals with Parkinson's disease, stroke, and other neurological disorders often experience persistent impairments in gait, balance, and movement coordination.

Physiotherapy remains indispensable during early rehabilitation because individualized assessment allows therapists to address specific neurological deficits through task-oriented practice, gait training, and motor relearning.

Once functional stability has improved, Tai Chi may be introduced to enhance balance, movement confidence, and long-term physical activity. This sequential approach may improve both functional recovery and patient adherence.

8.5 Community-Based Rehabilitation

One of the greatest advantages of Tai Chi is its suitability for community-based rehabilitation.

Unlike many supervised physiotherapy interventions, Tai Chi can be practiced:

- in community centers,
- public parks,
- rehabilitation groups,
- residential care facilities,
- or independently at home.

This accessibility makes Tai Chi particularly valuable in rural or resource-limited settings where access to rehabilitation professionals may be limited.

8.6 Integrated Rehabilitation Model

The evidence supports an integrated rehabilitation pathway in which physiotherapy and Tai Chi complement one another.

A proposed model includes:

Phase 1 – Acute Rehabilitation

- Pain management
- Manual therapy
- Joint mobilization
- Progressive strengthening
- Functional exercise

↓

Phase 2 – Functional Recovery

- Balance training
- Gait retraining
- Neuromuscular re-education
- Functional task practice

↓

Phase 3 – Long-Term Maintenance

- Tai Chi
- Home exercise
- Community exercise groups
- Fall prevention
- Lifelong physical activity

This integrated model combines the strengths of evidence-based physiotherapy with the long-term sustainability of Tai Chi.

9. Limitations

Although this systematic review provides a comprehensive comparison of Tai Chi and physiotherapy, several limitations should be considered when interpreting the findings.

First, considerable heterogeneity existed across the included studies regarding participant characteristics, intervention protocols, Tai Chi styles, physiotherapy techniques, treatment duration, and outcome measures. Such variability limited direct comparisons between studies and precluded quantitative meta-analysis.

Second, intervention durations ranged from six to twenty-four weeks, with relatively few studies including long-term follow-up beyond one year. Consequently, the durability of treatment effects remains uncertain.

Third, blinding of participants and therapists was generally impossible because of the nature of rehabilitation interventions. This limitation increases the potential risk of performance and detection bias.

Fourth, many studies enrolled older adults with chronic musculoskeletal disorders, limiting the generalizability of findings to younger individuals, athletes, or patients with acute traumatic injuries.

Finally, publication bias cannot be excluded, as studies reporting positive findings are more likely to be published than those with negative or inconclusive results.

Despite these limitations, the methodological quality of most included studies was moderate to high, supporting confidence in the overall conclusions of this review.

10. Future Directions

Future research should focus on several key areas to strengthen the evidence base for Tai Chi and physiotherapy.

Large multicenter randomized controlled trials using standardized intervention protocols are required to improve comparability across studies. Consistent reporting of Tai Chi style, treatment frequency, exercise intensity, and physiotherapy components would facilitate future evidence synthesis.

Long-term follow-up studies extending beyond two years are needed to determine the sustainability of improvements in pain, balance, mobility, and quality of life.

Future investigations should also evaluate integrated rehabilitation programs combining physiotherapy with Tai Chi rather than examining these interventions in isolation. Such studies may identify optimal treatment sequencing and dosage.

Cost-effectiveness analyses should be conducted to determine whether community-based Tai Chi programs reduce healthcare utilization, hospitalization, and fall-related injuries among older adults.

Emerging technologies, including wearable sensors, inertial measurement units, artificial intelligence-based movement analysis, and tele-rehabilitation platforms, may enhance objective assessment of treatment outcomes and improve patient monitoring outside traditional clinical settings.

Finally, future research should investigate the neurophysiological mechanisms underlying Tai Chi, including its effects on neuroplasticity, cognitive function, autonomic regulation, and motor learning.

11. Conclusion

Tai Chi and physiotherapy are effective non-pharmacological interventions for improving pain, balance, functional mobility, muscle strength, gait performance, and health-related quality of life among individuals with musculoskeletal disorders, neurological conditions, and age-related balance impairments. While physiotherapy remains the cornerstone of individualized rehabilitation, particularly during the acute and post-operative phases of recovery, Tai Chi offers substantial benefits in long-term balance enhancement, fall prevention, psychological well-being, and sustained participation in physical activity. The evidence synthesized in this review indicates that neither intervention should be regarded as universally superior. Instead, each addresses different dimensions of rehabilitation and possesses unique therapeutic strengths. Physiotherapy provides targeted correction of biomechanical impairments, restoration of muscle strength, and structured functional recovery, whereas Tai Chi promotes postural control, proprioception, movement confidence, mindfulness, and long-term exercise adherence.

An integrated rehabilitation approach combining physiotherapy with Tai Chi appears to offer the greatest potential for optimizing clinical outcomes across diverse patient populations. Such a model supports both short-term recovery and long-term maintenance of physical function while addressing psychological and social aspects of health.

Future high-quality multicenter randomized controlled trials employing standardized intervention protocols, longer follow-up periods, and comprehensive outcome assessment are needed to establish definitive clinical guidelines for integrating Tai Chi into routine physiotherapy practice.

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