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"Reactive Neuro-Agility Rehabilitation in Chronic Ankle Instability: Reframing the Illinois Agility Test as a Sensorimotor Recovery Biomarker in Younger Adults": A Narrative Literature Review

Ruchika Pal[1], Abhay Kumar[2], Aditi Singh[3]

[1]Associate Professor, Department of Physiotherapy, Jagannath University, Sitapura, Jaipur, Rajasthan
[2]MPT Sports Science, Department of Physiotherapy, Jagannath University, Sitapura, Jaipur, Rajasthan India
[3]Professor & HoD, Department of Physiotherapy, Jagannath University, Sitapura, Jaipur, Rajasthan

Abstract

Chronic ankle instability (CAI) is one of the most common musculoskeletal conditions affecting younger adults, particularly athletes and physically active individuals. Recurrent ankle sprains often lead to impaired proprioception, neuromuscular deficits, reduced balance, and decreased agility performance. The Illinois Agility Test (IAT) is widely used as a functional outcome measure to evaluate agility, speed, directional control, and dynamic stability following rehabilitation in individuals with ankle instability. This review article aims to evaluate the effectiveness of rehabilitation interventions on Illinois Agility Test performance among younger adults with chronic ankle instability. Literature was reviewed from PubMed, Google Scholar, Scopus, and rehabilitation databases focusing on balance training, neuromuscular rehabilitation, proprioceptive exercises, strengthening programs, and functional rehabilitation approaches. Evidence suggests that rehabilitation significantly improves agility, dynamic balance, proprioception, and functional ankle performance, reflected by reduced Illinois Agility Test completion times. Combined rehabilitation approaches integrating balance training, strengthening exercises, neuromuscular retraining, and plyometric exercises demonstrated superior improvements compared to isolated interventions. Early rehabilitation and functional performance assessment using the Illinois Agility Test are essential for safe return to activity and prevention of recurrent ankle injury.

Keywords: Chronic ankle instability, Illinois Agility Test, rehabilitation, proprioception, neuromuscular training, younger adults, ankle sprain, agility performance

1. Introduction

Ankle sprains are among the most common musculoskeletal injuries encountered in sports and physically active populations, accounting for a significant proportion of lower extremity injuries in younger adults

[1]. Lateral ankle sprains particularly affect athletes involved in running, jumping, and rapid directional changes. Although many individuals recover following the initial injury, approximately 30–40% develop chronic ankle instability (CAI), characterized by recurrent sprains, episodes of "giving way," pain, impaired balance, and functional limitations [2].

Chronic ankle instability is associated with sensorimotor deficits including impaired proprioception, neuromuscular dysfunction, delayed peroneal muscle activation, reduced postural control, and altered gait mechanics [3]. These impairments negatively affect agility, coordination, athletic performance, and functional mobility. Younger adults with CAI frequently demonstrate difficulty performing rapid multidirectional movements required in sports and recreational activities [4].

Functional performance tests play an important role in evaluating rehabilitation outcomes and return-to-sport readiness in individuals with ankle instability. Among these assessments, the Illinois Agility Test (IAT) is widely used to assess speed, agility, coordination, acceleration, and directional control [5]. The test requires rapid running and directional changes around cones, thereby challenging dynamic balance, neuromuscular control, and lower limb stability.The Illinois Agility Test provides objective quantification of agility performance by measuring the time required to complete a standardized agility course. Reduced completion time following rehabilitation reflects improvements in dynamic stability, motor control, and functional performance [6]. Rehabilitation for chronic ankle instability commonly includes proprioceptive training, balance exercises, neuromuscular retraining, strength conditioning, plyometric drills, and sport-specific agility exercises [7]. Evidence suggests that such interventions improve postural control, functional performance, and joint stability while reducing risk of recurrent injury [8]. Neuromuscular rehabilitation enhances sensorimotor integration and dynamic stabilization by improving afferent feedback and muscular coordination [9]. Balance training interventions using wobble boards, unstable surfaces, and single-leg tasks have shown particularly strong evidence in improving dynamic postural control and agility outcomes [10].

Recent studies also emphasize the importance of integrated rehabilitation programs combining strength training, proprioceptive exercises, and agility drills for optimizing functional recovery in younger adults with CAI [11]. Functional outcome measures such as the Illinois Agility Test therefore provide valuable insight into rehabilitation effectiveness and readiness for return to physical activity. This review article aims to evaluate the role of rehabilitation in improving Illinois Agility Test performance among younger adults with chronic ankle instability and to synthesize current evidence regarding functional recovery, agility enhancement, and neuromuscular rehabilitation outcomes.

2. Methodology

Study Design

This review was conducted as a narrative review to synthesize evidence regarding the effects of rehabilitation on Illinois Agility Test performance in younger adults with chronic ankle instability.

Search Strategy

A comprehensive literature search was conducted using electronic databases including PubMed, Google Scholar, Scopus, PEDro, and sports rehabilitation journals. Studies published between 2010 and 2025 were considered for inclusion.

Search terms included:

- "Illinois Agility Test and ankle instability"
- "Chronic ankle instability rehabilitation"
- "Agility performance after ankle rehabilitation"
- "Neuromuscular training in chronic ankle instability"
- "Balance training and ankle agility"
- "Functional rehabilitation and Illinois Agility Test"
- "Younger adults with ankle instability"

Combined search phrases included:

- "Illinois Agility Test AND chronic ankle instability"
- "Rehabilitation AND agility performance AND ankle sprain"
- "Neuromuscular training AND ankle instability"

Relevant studies from PubMed, Google Scholar, and Scopus databases were reviewed.

Inclusion Criteria

Studies were included if they:

- Investigated chronic ankle instability in younger adults
- Evaluated rehabilitation interventions
- Included agility or functional performance outcomes
- Used randomized controlled trials, comparative studies, or systematic reviews
- Were published in English-language peer-reviewed journals

Exclusion Criteria

Studies were excluded if they:

- Focused on acute fractures or surgical populations
- Included neurological disorders affecting gait
- Were case reports or conference abstracts

- Did not assess functional rehabilitation outcomes

3. Results

Table 1. Descriptive Review of Included Studies on Rehabilitation and Agility Performance in Chronic Ankle Instability

S.No	Author(s) & Year	Study Design	Population	Intervention	Outcome Measures	Key Findings
1	Wang et al. (2023) [28]	Systematic review	Individuals with CAI	Dual-task training	Dynamic balance & agility	Improved postural stability and functional ability
2	O'Driscoll & Delahunt (2011) [27]	Systematic review	Subjects with CAI	Neuromuscular training	Functional stability	Significant improvement in dynamic postural control
3	Kim & Moon (2022) [26]	Meta-analysis	CAI patients	Joint mobilization	Dynamic balance & ROM	Improved movement control and ankle mobility
4	Webster & Gribble (2010) [25]	Systematic review	Athletes with CAI	Functional rehabilitation	Functional performance	Rehabilitation improved agility and self-reported function
5	Liu et al. (2025) [24]	Systematic review	Patients with CAI	Blood flow restriction training	Functional ankle outcomes	Improved postural control and muscle activation
6	Li et al. (2022) [23]	Network meta-analysis	CAI individuals	Strength & proprioceptive training	Joint position sense	Strengthening exercises most effective
7	Donovan et al. (2021) [22]	Systematic review	Recreational athletes	Balance and hip strengthening	SEBT and agility	Wobble board training improved dynamic control
8	Hertel et al. (2019) [21]	Clinical study	Young athletes	Balance rehabilitation	Agility and coordination	Reduced agility test completion time

S.No	Author(s) & Year	Study Design	Population	Intervention	Outcome Measures	Key Findings
9	McKeon et al. (2018) [20]	Experimental study	Physically active adults	Neuromuscular rehabilitation	Illinois Agility Test	Significant improvement in agility performance
10	Hall et al. (2017) [19]	Comparative study	Younger adults with CAI	Plyometric and balance training	Functional agility	Combined interventions yielded superior results

The reviewed studies consistently demonstrated that rehabilitation interventions improve agility, dynamic balance, proprioception, and functional ankle performance in younger adults with chronic ankle instability [19–28]. Significant reductions in Illinois Agility Test completion time were observed following neuromuscular training, proprioceptive rehabilitation, balance exercises, and strength conditioning programs.

Balance training using wobble boards and unstable surfaces improved dynamic postural control and multidirectional movement performance [22,25]. Neuromuscular rehabilitation enhanced sensorimotor coordination and reduced episodes of instability [20,27].

Strengthening exercises targeting ankle stabilizers and hip musculature improved functional performance and directional control [21,23]. Combined rehabilitation approaches integrating agility drills, balance Exercises, And Plyometric Training Produced the Greatest Improvements In Agility Outcomes [19].

4. Discussion

The findings of this review indicate that rehabilitation significantly improves Illinois Agility Test performance among younger adults with chronic ankle instability. Chronic ankle instability affects dynamic postural control, proprioception, muscular coordination, and agility performance, thereby limiting athletic and functional abilities [20,27].

The Illinois Agility Test is particularly valuable because it evaluates rapid acceleration, deceleration, directional changes, and dynamic stability simultaneously. These components are often impaired in individuals with chronic ankle instability due to neuromuscular deficits and impaired sensorimotor control [21].

Neuromuscular rehabilitation demonstrated strong evidence for improving agility performance. Such interventions enhance proprioceptive feedback, reflex stabilization, muscular coordination, and joint position awareness [27]. Improved neuromuscular control likely contributes to reduced Illinois Agility Test completion times by enhancing movement efficiency and directional control.

Balance training interventions also demonstrated substantial effectiveness. Wobble board exercises, single-leg balance tasks, and unstable surface training improve postural stability and ankle joint control during dynamic activities [22,25]. Since agility tasks require rapid stabilization during directional transitions, improved balance directly influences Illinois Agility Test performance.

Strengthening exercises targeting the ankle evertors, plantar flexors, dorsiflexors, and proximal hip musculature contributed to enhanced lower extremity stability and force generation [23]. Adequate muscular strength is essential for rapid acceleration and deceleration during agility tasks.

Plyometric and sport-specific agility exercises further improved movement speed, reaction time, and neuromuscular responsiveness [19]. These exercises simulate functional sports demands and prepare individuals for return to athletic participation.

The review also highlights the importance of combined rehabilitation approaches. Interventions integrating balance training, strengthening exercises, neuromuscular retraining, and agility drills consistently produced superior outcomes compared to isolated interventions [19,24]. This multidimensional approach addresses both mechanical instability and sensorimotor deficits associated with CAI.

From a physiotherapy perspective, the Illinois Agility Test serves as a reliable and practical clinical tool for monitoring rehabilitation progress and determining return-to-sport readiness. Improvements in agility performance may indicate restoration of functional stability and reduced injury risk.

Despite positive findings, variability in rehabilitation protocols, intervention duration, and functional outcome measures limits direct comparison across studies. Future research should investigate standardized rehabilitation protocols and long-term effects of agility-focused rehabilitation programs.

Overall, evidence supports the use of rehabilitation interventions to improve Illinois Agility Test performance, agility, dynamic stability, and functional recovery in younger adults with chronic ankle instability.

5. Limitations

This review has several limitations. Included studies demonstrated variability in intervention protocols, sample size, rehabilitation duration, and functional outcome measures. Some studies focused primarily on balance outcomes rather than direct Illinois Agility Test assessment. Additionally, heterogeneity among study designs limited direct comparison across findings. Only English-language studies were included, potentially excluding relevant evidence from other languages.

6. Conclusion

Rehabilitation significantly improves Illinois Agility Test performance in younger adults with chronic ankle instability. Neuromuscular training, balance exercises, strengthening programs, proprioceptive rehabilitation, and plyometric training contribute positively to agility, dynamic stability, and functional ankle performance. Combined rehabilitation approaches demonstrated the most effective outcomes in reducing agility test completion time and restoring functional movement. The Illinois Agility Test remains

a valuable clinical tool for assessing rehabilitation progress and return-to-sport readiness in individuals with chronic ankle instability.

Conflict of Interest

The authors declare no conflict of interest related to this review.

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