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The Effect of Kinesiology Tape on Biomechanics and Proprioception in Patients with Chronic Ankle Instability: A Systematic Review and Meta-Analysis

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ABSTRACT

Aims: This study investigated the effects of Kinesiology Tape (KT) on proprioception in individuals with Chronic Ankle Instability (CAI), immediately after application and at delayed follow-up, compared to a control group.

Method and Materials: A systematic review and meta-analysis were conducted in accordance with the PRISMA 2020 guidelines. Five databases (PubMed, Embase, Scopus, Web of Science, and Cochrane Library) were searched using keywords related to "ankle instability," "kinesio tape," and "proprioception." Controlled studies assessing stability and proprioception with the Y-balance test and Sensory Organization Test (SOT) composite score, both at baseline and within two months, were included. Case series and studies lacking usable data at both time points or without controls were excluded. Three studies (n = 123 participants) met criteria for the primary analysis and five studies (n = 235 participants) for the secondary analysis. Data were analyzed using a random-effects model in IBM SPSS, version 29.

Findings: All groups, including controls, showed significant improvements in proprioception from baseline ($p < 0.05$). Immediate KT application improved proprioception ($p = 0.02$, Cohen's $d = -0.53$ [-0.96, -0.09], $I2 = 0\%$), but did not differ from the control group ($p = 0.1$). Extended KT use yielded significant proprioceptive improvements ($p \leq 0.001$, Cohen's $d = -1.77$ [-2.16, -1.39], $I2 = 0\%$) that were significantly superior to controls ($p \leq 0.001$).

Conclusion: Kinesiology tape is widely used after ankle injuries, but evidence for its effectiveness in CAI is limited. In this study, a random-effects pooled analysis found no significant differences in proprioception between KT users and controls at immediate or delayed follow-up.

Keywords: Joint Instability, Ankle Injuries, Athletic Tape, Proprioception

Introduction

Ankle sprains are the most common lower extremity injury prompting emergency department visits in the United States [1, 2]. Many of these injuries involve the lateral ankle ligaments, including the Anterior Talofibular Ligament (ATFL), calcaneofibular ligament, and posterior talofibular ligament. Among these, the ATFL is the most commonly injured [3]. The majority of these injuries can be successfully treated with conservative management; 10-20% of patients will develop Chronic Ankle Instability (CAI) regardless of initial treatments [4].

Although there is currently no universally accepted or standardized definition of CAI [5], it is generally characterized by or the sensation of the ankle recurrent episodes of instability 'giving out' following an initial injury. The underlying pathophysiology involves both mechanical deficits, such as ligamentous laxity, and functional deficits, including impaired proprioception and delayed neuromuscular control. These impairments hinder the ability to effectively compensate for proprioceptive inputs, leading to delayed neuromuscular activation and a subsequent loss of static and dynamic balance [6-10]. Several tools are used to assess CAI, including subjective measures such as the Cumberland Ankle Instability Tool and objective tests such as the Y-Balance Test, Star Excursion Balance Test (SEBT), and force-plate analysis of center-of-pressure readings [11-14]. While surgical reconstruction is an option for persistent CAI,

Kinesiology Tape (KT) offers a non-invasive alternative that may assist with proprioceptive training and functional support [15].

Kinesiology Tape is an elastic therapeutic tape widely used to manage musculoskeletal conditions, including CAI. It is hypothesized to enhance proprioception by stimulating cutaneous receptors, providing mild mechanical support, and improving local circulation through its elastic properties [16-18]. Despite its growing popularity, evidence on KT's effectiveness remains mixed, with some studies reporting functional benefits and others finding minimal or no objective improvements [19-22].

This study aims to evaluate the effect of KT on proprioception in individuals with CAI, addressing the current lack of clear evidence supporting its therapeutic use.

Method and Materials

A systematic review and random-effects meta-analysis were performed using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines [23]. A systematic search of PubMed, Medline, Cochrane, Embase, and Web of Science was conducted on January 6, 2024, to identify randomized controlled trials (RCTs) evaluating the effects of KT on CAI. Relevant keywords were derived from MeSH terms and combined using an appropriate Boolean search string. The search string used was '("ankle instability") AND ("emg" OR "electromyography" OR "muscle activation" OR "strength" OR "Pain" OR "VAS" OR "proprioception" OR "Balance" OR "Stabilization" OR "Force") AND ("KT" OR "kinesio tape" OR "therapeutic tape" OR "kinesiology tape" OR "k-tape")'. Additionally, Google Scholar and the references of the retrieved studies were manually and extensively searched for articles that met the inclusion criteria, but no additional papers were found.

Of 207 articles identified, 123 duplicates were removed using Rayyan.ai's 95% similarity detection tool and manual screening. The remaining 84 abstracts were assessed for eligibility by two independent reviewers, resulting in 11 full-text articles. Of these, five studies (n = 230 participants) met the final inclusion criteria for analysis.

Included studies were randomized controlled trials assessing the effect of KT on CAI from any publication year. Studies that evaluated stability, balance, or proprioception pre- and immediately post-application were included in the primary analysis. To minimize confounding factors, studies that used KT with exercise, longitudinal studies, and studies with both short-term and longitudinal data were included in the secondary analysis instead. Those who did not report mean pain data pre- and post-intervention (n=1) were excluded entirely. Five articles were included in the study, with three in the primary analysis of immediate outcomes, four in the analysis of intermediate outcomes, and some represented in both groups. The flow diagram for the study selection procedure is shown in Figure 1.

Given the multiple outcomes reported in each study, only data directly assessing ankle stability were included in the quantitative analysis. The remaining data were extracted and summarized in an evidence chart. To assess CAI, outcomes such as the Y Balance Test, proprioception, and the Sensory Organization Test (SOT) composite score were synthesized. Outcome selection was based on expert consensus to maximize internal validity for the meta-analysis. The anterior Y Balance Test was preferred over the posterior-medial or lateral directions, as the latter require greater dorsiflexion, resulting in a more stable closed-pack ankle position. To maximize sensitivity to instability, the anterior reach direction was selected. In one study, objective force-plate data were used in preference to dynamic movement assessments. Mean values, standard deviations (SD), and participant numbers were collected for pre- and post-intervention analysis in both the KT and control groups. This data was used in a pooled analysis to determine changes in stability scores. Effect size was reported for each study, as well as for the KT and control groups collectively, and was assessed using statistical significance ($p < 0.05$) and standardized mean

difference (Cohen's d, 95% confidence interval [LL, UU]). Since effect size is a pooled metric, variation in outcome measurement scales did not impact the overall analysis,

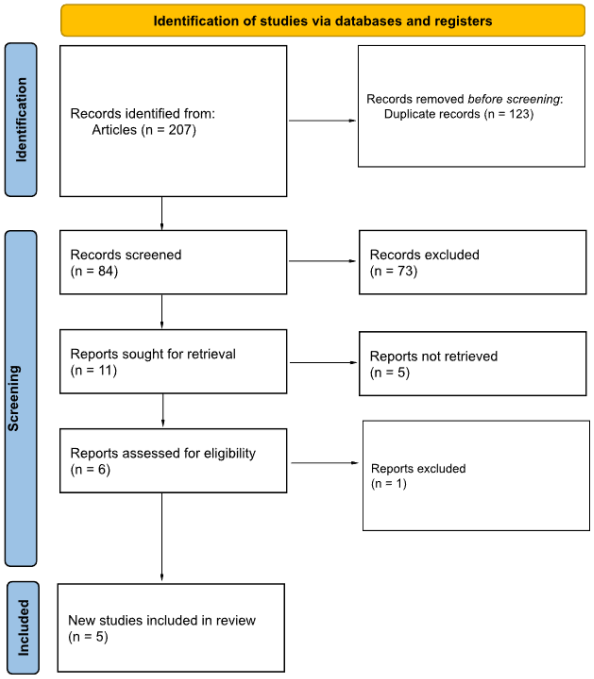

Figure 1) Identification of new studies via databases and registers

aside from limiting data aggregation. Each data point was entered such that improvement in the scoring system represented an increase in proprioception. A random-effects meta-analysis was conducted on pre-post data for both groups using IBM SPSS Statistics for Windows, Version 29 [24]. A fixed-effects model was not used to maintain a more conservative approach, given the potential influence of unmeasured confounding variables. Heterogeneity was assessed using chi-squared (Q), degrees of freedom (df), and associated P-values ($P < 0.05$), as visualized in the forest plot (Figure 2). Significant subgroup differences were interpreted as meaningful differences between the KT and control groups.

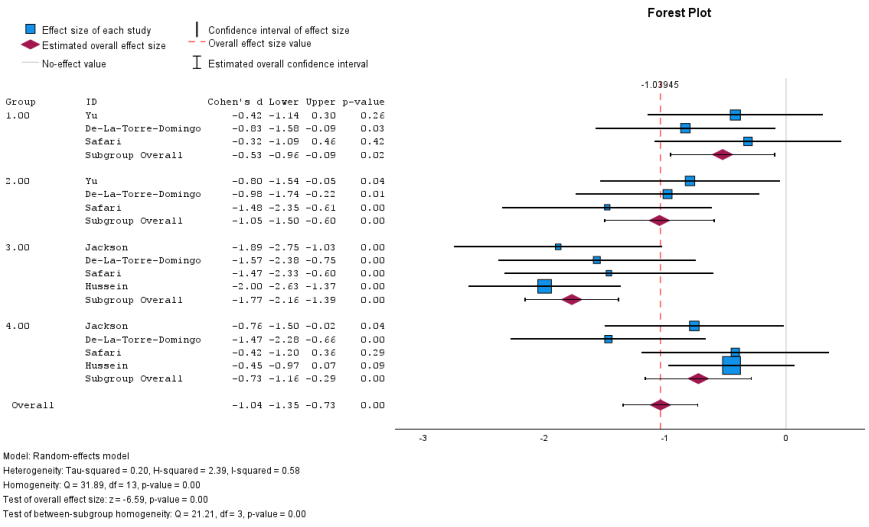

Figure 2) Forest plot displaying individual and pooled effect sizes for KT vs. control on measures of ankle instability. Subgroups include: 1 = Control Immediate, 2 = KT Immediate, 3 = KT Intermediate, 4 = Control Intermediate.

Heterogeneity was assessed using Cochran's Q, τ^2, H^2, and the I^2 statistic, with I^2 used as the primary measure of heterogeneity. Here, τ^2 represents the estimated variance of accurate effect sizes, H^2 is the ratio of total variability to sampling variability, and I^2 quantifies the percentage of variability due to heterogeneity rather than random chance. Data on the long-term application of KT were excluded from the meta-analysis to reduce potential confounding due to time-dependent effects. Nonetheless, these findings, along with other relevant results not included in the quantitative synthesis, are described in the narrative review presented in the Results and Discussion sections.

Certainty of Evidence and Risk of Bias Assessment

Risk of bias for the included randomized controlled trials was independently assessed by two authors using the Cochrane Risk of Bias-2 (RoB-2) tool [25]. Visual representations of these assessments were generated using the ROBVIS tool, including a stoplight plot summarizing domain-level judgments across studies (Figure 3) [26]. The overall certainty of the evidence was evaluated using the Grading of Recommendations Assessment, Development, and Evaluation (GRADE) framework [27], which considers study design, consistency of results, directness, precision, and risk of publication bias. Results from RoB-2 are presented in Figure 3, while the results of the GRADE evaluation are reported narratively in the text. Collectively, these tools offer a robust assessment of methodological quality and overall evidence certainty.

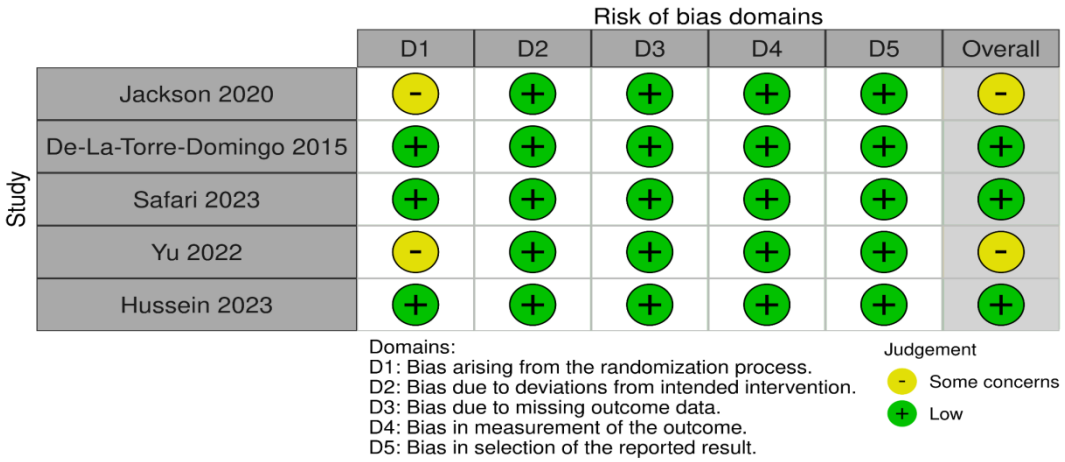

Figure 3) Traffic light plot of Risk of Bias assessment using ROB-2.

Findings

T Key data from all included studies were extracted and summarized (Figure 4). The primary outcome assessed was the effect of KT application on measures of ankle instability, both immediately after application and after prolonged use. Both short- and long-term KT applications, and their control groups, showed statistically significant improvements ($p < 0.05$) in proprioception. Immediate application of KT resulted in significantly improved proprioception from baseline ($p = 0.02$, Cohen's d = -0.53 [-0.96, -0.09], I2 = 0%). Still, it was not significantly different from the control group ($p = 0.1$), as seen in the subgroup analysis of homogeneity (Figure 3). The extended KT application also resulted in statistically significant improvements in proprioception ($p = 0.00$, Cohen's d = -1.77 [-2.16, -1.39], I2 = 0%) that were significantly different from those of the control group ($p = 0.00$) on subgroup analysis of homogeneity (Figure 4).

Risk of Bias and Certainty of Evidence Assessment

A comprehensive evaluation of bias risk and evidence certainty was conducted for the selected studies using the ROB-2 tool. The finalized Risk of Bias 2 (ROB-2) plot (Figure 3)

TITLE	STUDY ID (FIRST AUTHOR, YEAR)	COUNTRY	STUDY DESIGN	INTERVENTION (EXP v CTR)	# OF PATIENTS (EXP v CTR)	AGE MEAN (EXP v CTR)	BMI (EXP v CTR)	GENDER, M/F (%) (EXP v CTR)	INCLUSION CRITERIA	OUTCOMES COLLECTED	OUTCOMES MEASURED
Effect of Kinesiology Tape on Measurements of Balance in Subjects with Chronic Ankle Instability: A Randomized Controlled Trial	De-La-Torre-Domingo, C., 2015	Spain	Single-Blind RCT	KT Tape vs Placebo Tape	15 vs 15	18.87 vs 20.07	22.63 vs 22.82	5/10 vs 10/5	Hx of at least one acute lateral ankle sprain that resulted in swelling, pain, and temporary loss of function (but none in past 3 months); Hx of multiple episodes of ankle giving way in past 6 months; Cumberland Ankle Instability Tool (CAIT) score <27; Evidence of mechanical instability assessed by physician using anterior drawer test (anterior drawer difference of 10mm compared to contralateral ankle).	Baseline, immediately after taping, and after 7 days of use	Composite Sensory Organization Test (SOT) Score, Composite SOT Strategy, SOT Condition 2 Score, SOT Strategy 2 Score
The Immediate Effect of Synergistic Muscles Kinesio Taping on Function and Balance of Volleyball Players with Functional Ankle Instability: A Randomized Controlled Trial	Safari, S., 2023	Iran	Parallel, Superiority RCT	KT with 35% Tension vs KT without Tension	13 vs 13	25.08 vs 24.14	2.91 vs 23.16	0/26	Volleyball players with age <30; Hx of Lateral Ankle Sprain (LAS) within past 12 months; Report of at least two episodes of "giving way" feeling in past 6 months; CAIT score ≤ 24; Score < 90 % on the daily activities section and < 80 % on the sports activities section of the Persian version of Foot and Ankle Ability Measure (FAAM) Questionnaire.	Baseline, 20 minutes, and 24 hours after taping	Function via Side Hop and Single Hop Distance Test, Dynamic Balance via Y-Balance Test - Anterior Direction
Extended Use of Kinesiology Tape and Balance in Participants With Chronic Ankle Instability	Jackson, K., 2016	USA	RCT	KT vs Control	15 vs 15	19.9 vs 20.9	24.61 vs 25.70	4/11 vs 8/7	Hx of at least one lateral ankle sprain; Experienced sensation of "giving way" at least once within the last 6 months; a score of 11 or more on the Identification of Functional Ankle Instability (IdFAI)	Baseline, 48 hours after (with tape applied), and 72 hours after (with tape removed)	Balance via the Balance Error Scoring System (BESS)
Kinesiology Tape Length and Ankle Inversion Proprioception at Step-Down Landing in Individuals with Chronic Ankle Instability	Yu, R., 2021	Australia	RCT with Repeat Measures	KT with CAI vs KT without CAI	15 vs 15	23.9 vs 23.1	21.37 vs 21.01	7/8 vs 8/7	Hx of at least one unilateral significant ankle sprain; Hx of at least two episodes of the ankle joint "giving way" in the 6 months prior to study enrollment; a score of ≤ 24 on the CAIT Score	Baseline, short tape length (only foot and ankle complex involved), mid length (below the knee) and long length (above the knee) taping. The three different taping tests were in intervals of 24 hours and in random order	Proprioception via the Ankle Inversion Discrimination Apparatus for Landing (AIDAL)
The Effect of Kinesio Taping on Balance and Dynamic Stability in College-Age Recreational Runners with Ankle Instability	Hussein, H. M., 2023	Saudi Arabia	RCT	KT vs Exercise only	29 vs 29	32.69 vs 31.87	24.30 vs 25.78	25/4 vs 24/5	Healthy College-Age Males; BMI in the normal or overweight category; Regular Participation in Running Activities (1-3x/wk for the past 6 months); Past Hx of at least one LAS; and ankle instability with a CAIT Score Within 24-27.	Baseline and After 8 week Tx Program	Postural Stability via Biodex Balance System - Overall Stability Index (OSI), Anteroposterior Stability Index (APSI), Mediolateral Stability Index (MLSI), Dynamic Balance via Star Excursion Balance Test (SEBT) - Anterior Direction

Figure 4: Summary of findings Table.

reveals that only two studies exhibited moderate bias, specifically in randomization. However, this did not compromise the reliability of the objective findings regarding the effect of kinesiology tape on ankle instability. With an overall low risk of bias, the results maintain strong validity, further supporting conclusions on proprioception at different follow-up periods in ankle insufficiency data.

The certainty of evidence was assessed using the Cochrane Grading of Recommendations Assessment, Development, and Evaluation (GRADE) framework across five included studies (n = 204 participants). Overall certainty of evidence was rated as moderate. Evidence was not downgraded for risk of bias, as most studies demonstrated acceptable methodological quality. Serious inconsistency was identified due to heterogeneity across outcome measures; however, this did not substantially reduce confidence in the direction of effect. No serious concerns were identified regarding indirectness, as study populations, interventions, and outcomes were consistent with the predefined Population Intervention Control Outcome (PICO) framework. Imprecision was considered not serious, despite overlapping confidence intervals and relatively small sample sizes across studies. Publication bias was not detected, supported by a symmetrical funnel plot with few outliers.

Discussion

Kinesiology Taping (KT) is frequently utilized as a non-invasive intervention to enhance proprioception and functional performance in individuals with CAI. This systematic review and meta-analysis reinforce its clinical relevance, demonstrating statistically significant improvements in proprioceptive outcomes, particularly at delayed follow-up relative to baseline and control groups. The included studies exhibited low heterogeneity, indicating minimal variability across intervention effects and strengthening the consistency and generalizability of the findings. As KT appears to enhance proprioception in individuals with CAI, it is imperative to analyze each study's context, methods, and variable outcome measures to understand the findings.

De-La-Torre-Domingo et al. examined the effects of KT on balance in individuals with CAI, comparing KT for lateral ankle sprains to a placebo group [28]. Balance was assessed at baseline, immediately after application, and after seven days using composite SOT scores. Although both groups demonstrated improvements over time, only the KT group showed immediate post-application gains, and most measured parameters did not differ significantly between groups at subsequent time points. The study also used 'eversion force sense' - an assessment requiring force reproduction without visual feedback - to measure proprioception. This method may have lacked the sensitivity to detect subtle changes and may have been influenced by psychological factors, such as increased confidence or perceived stability following KT application.

Such psychological effects can potentially influence performance during balance assessments, contributing to non-significant

between-group findings despite physiological changes [21]. Importantly, even in the absence of statistically significant outcomes in this study, KT has been shown elsewhere to enhance joint position sense by stimulating cutaneous mechanoreceptors and augmenting afferent sensory input [29]. Additionally, neuromuscular fatigue can inhibit supra spinal drive, diminishing motor output and muscle activation [30]. KT's mechanistic benefits, such as improved proprioception through enhanced mechanoreceptor input, may lower sensory thresholds and facilitate quicker postural corrections via more responsive center-of-pressure adjustments [31]. These mechanical effects, in combination with increased psychological confidence, may help explain the overall significant findings observed in this meta-analysis.

Safari et al. examined the immediate effects of KT with and without tension on function and balance in volleyball players with functional ankle instability [32]. The Y-Balance Test in the anterior direction was administered at baseline, 20 minutes, and 24 hours post-taping. Both groups demonstrated significant improvements, with the KT with tension group showing superior results. This effect is likely attributable to the increased neuromuscular feedback resulting from the application of tape to the fibularis longus, gastrocnemius, and gluteus maximus muscles [33]. The application of tension in KT may enhance proprioceptive effects by providing continuous tactile stimulation to the skin and underlying tissues, thereby increasing the firing rates of cutaneous and muscle mechanoreceptors. This heightened sensory input may improve afferent signaling to the spinal cord, increasing motor neuron excitability and enhancing motor control and postural reflexes. However, the lack of explicit reporting of the use of tension in the KT group across the studies included in this review introduces a potential confounding variable, underscoring the need for more standardized methodologies in future research.

Hussein et al. examined the effects of KT on balance and dynamic stability in recreational runners with ankle instability, dividing participants into three groups: KT only (KTG), KT with exercises (mixed group-MG), and exercises only [34]. The Biodex Balance System and the SEBT were used to assess participants at baseline and after an 8-week exercise program. Significant improvements were observed in all groups, with the KTG group demonstrating superior mediolateral stability, while the MG group exhibited greater posterior and lateral improvements on the SEBT. Given that balance training is known to enhance proprioception [35], the inclusion of balance exercises in some studies may have introduced bias when comparing KT to no-KT controls. Nonetheless, Hussein et al.'s findings support the role of KT in improving proprioception in individuals with CAI, with the potential for balance training to amplify its effects, an area that warrants further investigation.

Jackson et al. examined whether KT improves balance deficits associated with CAI using the Balance Error Scoring System [36]. Participants were assigned to either a KT or a control group, with testing conducted at baseline, after 48 hours of KT application, and again 72 hours post-tape removal. Results showed significant improvements in balance after 48 hours, which persisted for 72 hours after tape removal, suggesting a sustained impact on proprioception. This finding aligns with the concept of sensory adaptation, in which receptors initially respond strongly to a stimulus but gradually become more sensitive after its removal [37]. This temporary increase in receptor responsiveness may account for the continued proprioceptive and balance benefits observed. These findings enhance the credibility and clinical relevance of KT for improving proprioception in CAI. However, research on its sustained effects beyond 72 hours remains limited, with Jackson et al. among the few studies to include follow-up after tape removal, underscoring the need for further investigation into its extended benefits.

The study by Yu et al. explored the impact of varying KT lengths on ankle inversion proprioception in individuals with and without CAI using the Ankle Inversion Discrimination Apparatus for Landing [22]. Data were collected at baseline and after

applying short, medium, and long tape lengths at 24-hour intervals in random order. The results showed a significant main and linear effect, with longer tape lengths enhancing proprioceptive performance when landing. Post-hoc analysis of the CAI group revealed that medium and long tape lengths significantly improved performance compared to no tape. However, since all groups received KT, the lack of a true control group introduces potential bias, which may have influenced the consistency and reliability of the results, potentially amplifying the observed effects. These findings support the therapeutic benefits of KT for CAI. However, further research with larger sample sizes and direct KT-to-no-tape comparisons in a broader CAI population is necessary to strengthen the results.

Despite heterogeneity among the included studies, the subgroup analysis in this systematic review and meta-analysis demonstrated homogeneity, effectively mitigating inconsistencies arising from varied outcome measures, interventions, and data collection timelines. This contributed to the reliability and statistical power of our findings on KT's effects on proprioception and ankle stability. The inclusion of the anterior y-balance test, due to its sensitivity in detecting changes in dynamic postural control, and the SOT composite score ensured accurate assessments of CAI. Additionally, the significant improvement in Y-Balance Test scores observed in the meta-analysis of dual-task training for CAI further supports the reliability of these measures [38].

Researchers seeking to replicate or expand upon these findings should carefully consider study design, sample size, and participant demographics, as these factors may contribute to heterogeneity. For example, Safari et al. included only female athletes, whereas Hussein et al. focused primarily on male recreational runners, thereby limiting the generalizability of the findings [32, 34]. Furthermore, the relatively young age and small sample sizes across the included studies may reduce statistical power and increase the risk of type II errors. Future research should prioritize larger, more demographically diverse cohorts and standardized outcome measures to improve the reliability, external validity, and clinical relevance of findings on KT in individuals with CAI.

Conclusion

Despite limited research on the efficacy of KT in those with chronic ankle insufficiency, kinesiology tape remains a popular alternative for improving performance following ankle injuries. This systematic review and meta-analysis found that kinesiology tape application leads to statistically significant improvements in proprioception in individuals with chronic ankle instability. While the immediate application of KT enhances proprioception relative to baseline, it does not differ significantly from control. However, prolonged KT use results in significantly greater proprioceptive improvements than control, suggesting a time-dependent effect. The included studies exhibit a low overall risk of bias, and evidence certainty is substantial, further validating these findings. These results indicate that KT may be an effective adjunct for managing ankle instability, particularly with extended use, but further research is required to confirm these findings.

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None declared by the authors.

Ethical Permission

This manuscript is a systematic review article. All ethical principles were considered in this study.

Authors' Contribution

All authors contributed to the conception and design of the study, data interpretation, and manuscript preparation. All authors reviewed and approved the final manuscript.

Conflicts of Interest

None declared by the authors.

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