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FOOT & ANKLE

# Effectiveness of functional or biomechanical bandages with athletic taping and kinesiotaping in subjects with chronic ankle instability: a systematic review and meta-analysis

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- *Purpose:* The aim of the study was to analyze the effects of functional or biomechanical bandages, whether elastic or inelastic, in Chronic Ankle Instability (CAI).
- *Methods:* This review used PubMed, WoS, SCOPUS, and CINAHL following PRISMA and registering in Prospero. Main PICOS: (1) CAI; (2) intervention, functional/biomechanical bandages; (3) comparison, taping effect versus placebo/no taping, or another functional taping; (4) outcomes, improvement of CAI functionality (dynamic/static balance, ankle kinematic, perception, agility and motor control, endurance and strength; (5) experimental and preexperimental studies. The meta-analyses considered mean and s.d. of the results per variable; effect size (ES) of each study and for each type of intervention. Homogeneity ($Q$), heterogeneity ($H^2$ and $I^2$), and 95% CI were calculated.
- *Results:* In total, 28 studies were selected. Significant differences were found for dynamic balance (66.66%) and static balance (87.5%), ankle kinematics (75.00%), perceptions (88.88%), plantar flexor strength (100%), muscle activity (66.6%), endurance (100%), functional performance (100%), and gait (66.6%). The main results of meta-analyses (eight studies) are as follows – *h/M* ratio soleus, ES: 0.080, 95% CI: −5.219–5.379; *h/M* ratio peroneus, ES: 0.070, 95% CI: −6.151–6.291; posteromedial KT, ES: 0.042 95% CI: −0.514–0.598; posteromedial—overall, ES: −0.006 95% CI: −1.071–0.819; mSEBT-KT, ES: 0.057 95% CI: −0.281–0.395; mSEBT—overall, ES: −0.035 95% CI: −0.190–0.590.
- *Conclusions:* All biomechanical or functional bandages, whether elastic or inelastic, applied in CAI were favorable, highlighting patient perception, dynamic and static balance, kinematics and agility and motor control, for its effectiveness and evidence. Thus, bandages increase ankle functionality. The meta-analyses found no statistical significance. Clinically, soleus muscle activity, h-reflex/M-responses using fibular reposition with rigid tape, and dynamic balance with combined kinesiotaping during the modified star excursion balance test and with the posteromedial direction found improvements.
- *Level of evidence:* Level of evidence according to Scottish Intercollegiate Guidelines Network: 1+. Level of evidence according to the Oxford Centre for Evidence-Based Medicine 2011: 1.

Keywords: joint instability; bandages; biomechanical phenomena; physical therapy modalities; ankle injuries; meta-analysis

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## Introduction

The ankle joint is a key element in basic activities of daily living (BADLs), especially in walking (1, 2). It facilitates the absorption of impacts and propulsion of the lower limbs, and stability in the load (3). In BADLs and sports, ankle sprains have the highest incidence (4). The lateral ligament complex is the most frequently injured (2, 5, 6, 7), and injury to this complex represents up to 85% of all ankle sprains (8).

Chronic ankle instability (CAI), defined as the repetitive appearance of instability, occurs in 40–70% of ankle sprains (9, 10, 11). CAI implies a subjective sensation that the ankle gives way and the appearance of repetitive sprains (12, 13). According to Van Rijn (14), these characteristics are ongoing for at least 1 year after the initial sprain. CAI includes mechanical and functional instability, separately or in combination (14, 15, 16, 17, 18); although recent research indicates that deficits associated with mechanical and functional instability must occur simultaneously to be considered chronic instability (19).

Thus, CAI disrupts static and dynamic balance, proprioception, range of motion (ROM) in ankle dorsiflexion, and muscle activation (20). These serious sequelae promote the need for an effective treatment (13, 21). There is evidence on the effectiveness of therapeutic exercise, focused on balance training (22, 23), proprioception in general (24) and force through proprioceptive neuromuscular facilitation (25). Currently, these treatments can complement each other and also include various types of functional bandages, the effectiveness of which has been demonstrated (26). Since functional bandages imply biomechanical components, this paper uses the concepts ‘functional bandage’ and ‘biomechanical bandage’ as synonyms. They produce partial or total limitations to the range of motion to fix or stabilize a joint or those that achieve postural corrections. To this end, force vectors are considered, involving traction or compressive forces in muscles, tendons, ligaments, etc. The biomechanical bandage aimed to offer the maximum possible functionality without causing further injury from existing pathologies or preventing their appearance. Neuromuscular techniques, which generally use kinesiotaping without biomechanical components to achieve analgesia and relaxation or a muscle stimulation effect, were therefore ruled out.

Consequently, we set ourselves the objective of performing a systematic review and meta-analysis to analyze the effects of functional or biomechanical bandages, whether elastic or inelastic, in CAI.

## Methods

The systematic review and meta-analyses were based on the PRISMA protocol (27) and registered in the Prospero database (CRD42022314156).

### PICOS question format

Population: subjects with chronic posttraumatic ankle instability due to ligament sprain. Note: This study only considered the comparison between CAI intervention groups, discarding groups composed of healthy subjects (healthy participants or healthy contralateral ankles) that could be included in the studies selected for other complementary analyses.

Intervention: application of a functional bandage (elastic and/or inelastic) using the biomechanical technique, i.e. partially or totally limiting the range of motion of the ankle to fix or stabilize it or achieving postural corrections. The neuromuscular technique to achieve analgesia, relaxation or stimulation effect was ruled out (see background). The bandages had to be applied directly on the affected ankle.

Comparison: effects of the application of a functional bandage with respect to (i) a placebo bandage or no bandage application; (ii) another functional bandaging technique; or (iii) a rigid and/or semirigid orthoses.

Outcomes: improved CAI functionality, whether immediate or short term (up to 7 days), assessed during the performance of a specific physical activity. The improvement may be objective and/or subjective, based on dynamic and static balance, ankle kinematic, subject perception, agility and motor control, endurance, and strength.

Study designs: experimental studies (randomized or nonrandomized controlled clinical trials) and preexperimental studies (study with repeated measures). Note: This review determined the design of the studies considering only the groups of subjects with CAI (see population).

Exclusion criteria: (i) non-English studies, (ii) patients with neurological deficit, (iii) studies that combine functional bandages with other physiotherapeutic treatments, (iv) patients with ankle surgery, (v) studies without means and standard deviations for each group or for each condition (in repeated measures studies) were excluded from quantitative analysis.

### Data sources and search strategy

An electronic search of PubMed, Web of Science (WoS), SCOPUS, and Cumulative Index to Nursing and Allied Health Literature (aka CINAHL) was conducted, without time limit, until May 7, 2023. The terms Medical Subject Headings currently existing on the topic of the review (in italics) were complemented by others to enhance the study. The following identifiers were used: (i) ‘athletic tape’ OR ‘orthotic tape’ OR tape OR taping OR bandage, (ii) ‘joint instability’ OR ‘joint instabilities’ OR ‘joint laxity’ OR ‘joint laxities’ OR ‘joint hypermobility’ OR ‘joint hypermobilities’ OR ‘ankle instability’ OR ‘chronic ankle instability’ OR ‘functional ankle instability’, and (iii) ankle.

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Hence, the search strategy used was adapted to the features of each database (Supplementary File 1, see the section on supplementary materials given at the end of this article).

## Study selection

The titles and abstracts of the search results were screened to check whether the study met the preestablished criteria. We obtained the full-text article that met the criteria and documented the causes for any exclusion. The selection process of the included studies was carried out by MB and subsequently by VP. Discrepancies were resolved by GC.

## Data extraction

Data extraction was carried out by two independent reviewers (MB, VP) who performed a screening to select relevant studies. If consensus was not reached, the final decision was made by a third reviewer (GC). The reviewers were not blinded to authors, date of publication or journal of publication.

They used a main table that was predesigned to detail information on study features, authors, year, purpose, design, participant characteristics, assessment tools, interventions, comparisons, and outcome measurements. Other predesigned tables summarized data on gender, physical activity, and scales used for inclusion criteria; the bandage techniques and materials used; and the significance and effectiveness of those variables. Data on quality appraisal of the studies were included in a standardized table and figure (see next section). All these data were used for the qualitative analysis.

## Quality appraisal

The methodological quality of the experimental studies was analyzed using two standard scales:

- The Physiotherapy Evidence Database (PEDro) scale (28, 29, 30) for studies with randomized groups. It was valid and reliable to evaluate the internal validity of a study and the adequacy of the statistical information for interpreting the results. The interpretation is 'poor' (scores ≤3), 'fair' (scores 4/5), and 'high' (scores ≥6/10) quality studies (31).
- The risk of Bias in nonrandomized studies of interventions (ROBINS-I) (32) tool is based on the Cochrane risk of bias tool for randomized trials. Their domains are confusion and selection of participants into the study, address issues before the start of the interventions ('baseline'), classification of the interventions themselves, and issues after the start of interventions: biases due to deviations from intended interventions, missing data, measurement of outcomes, and selection of the reported result. The categories are 'Low risk' (high-quality studies), 'Moderate risk', 'Serious risk', and 'Critical risk' of bias (32).

## Meta-analysis

The following were used for the analysis and interpretation of the data: means and S.D. of the results of each variable analyzed, effect size (ES) of each study and for each type of intervention.

The ES of each article and the overall ES of each type of intervention (bandage technique) were calculated. The *Q*-statistic was calculated to test whether the ES are homogeneous with respect to each other ($P < 0.05$ will show heterogeneity). We also calculated the $H^2$ index, necessary for the calculation of $I^2$ heterogeneity (0–100%), i.e. the percentage of relative heterogeneity between ES (33).

Forest plots represented the CI of the ES values. The CI used was 95%, the inclusion of zero is not being considered significant.

The SPSS 26 statistical package (SPSS, Inc.) was used.

# Results

## Search results

A total of 962 articles were found. After applying database filters and eliminating duplicates, 151 articles were reviewed by title, abstract, and full text to verify the inclusion criteria. After screening, 28 studies were included. Figure 1 shows the search process and selection of studies following the PRISMA protocol (27).

## Qualitative results per study and grouped

### Characteristics of included studies

A detailed summary of the features and results of each selected study is shown in Supplementary Table 1.

### Design and quality assessment

Regarding the design of experimental studies, six randomized controlled trials were found (18, 36, 40, 47, 51, 56), of which two were crossover (36,40) and one a quasi-randomized controlled trial (51).

Twenty-two preexperimental repeated-measures studies were found (12, 26, 34, 35, 37, 38, 39, 41, 42, 43, 44, 45, 46, 48, 49, 50, 52, 53, 54, 55, 57, 58), two of which were also crossover (37, 49).

The methodological quality of the six studies evaluated with the PEDro scale (18, 36, 40, 47, 51, 56) obtained a

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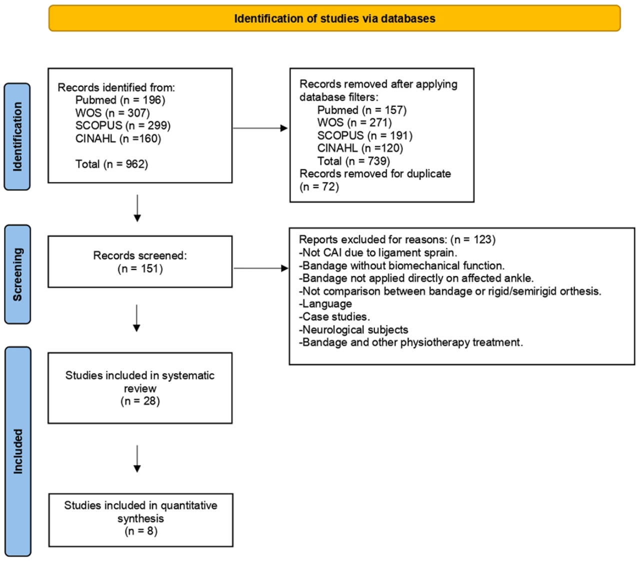


**Figure 1**

PRISMA flow diagram.

score between 6 and 9 (Table 1). The 22 nonrandomized studies analyzed with ROBINS-I tool (32) showed a serious risk of bias in dimension 6 (measurements of outcomes). Dimensions 2 (selection of participants), 5 (missing data), and 7 (selection of the reported results) indicated a moderate risk of bias for several of the studies evaluated. The overall rating was considered as seriously at risk of bias (Fig. 2).

**Table 1** Quality assessment. All the studies specified the eligibility criteria.

| Study | PEDro criteria | | | | | | | | | | Total score |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
| Wheeler *et al.* (36) | ✓ | ✗ | ✓ | ✗ | ✗ | ✓ | ✓ | ✗ | ✓ | ✓ | 6 |
| Grindstaff *et al.* (40) | ✓ | ✓ | ✓ | ✓ | ✗ | ✗ | ✓ | ✗ | ✓ | ✓ | 7 |
| De la Torre Domingo *et al.* (18) | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | 9 |
| Alguacil Diego *et al.* (47) | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | 9 |
| Alves *et al.* (49) | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✗ | ✓ | ✓ | 8 |
| Yen *et al.* (51) | ✗ | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ | ✓ | ✗ | ✓ | 5 |
| Haddadi *et al.* (56) | ✓ | ✓ | ✓ | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | 8 |

PEDro criteria: (1) subjects were randomly allocated to groups; (2) allocation was concealed; (3) groups were similar at baseline regarding the most important prognostic indicators; (4) there was blinding of all subjects; (5) there was blinding of all therapists who administered the therapy; (6) there was blinding of all assessors who measured at least one key outcome; (7) measures of at least one key outcome were obtained from more than 85% of the subjects initially allocated to groups; (8) all subjects for whom outcome measures were available received the treatment or control condition as allocated or, where this was not the case, data for at least one key outcome was analyzed by 'intention-to-treat'; (9) the results of between-group statistical comparisons are reported for at least one key outcome; (10) the study provides both point measures and measures of variability for at least one key outcome).

## Participant characteristics

A total of 592 subjects were included; 253 (42.7%) males and 235 (39.7%) females. The gender was not specified in 104 (17.6%) of the participants. The age ranged between 18 and 40 years, except in one study (42) with children aged 14.11 ± 0.33.

Other summary characteristics found in the study samples are shown in Table 2.

## Intervention and assessment

Table 3 groups the bandaging techniques and materials identified, as well as the time between interventions and posttest assessments.

The groups of techniques combined with kinesiotape (KT) or with rigid bandage, covered the foot and distal third of the leg, and involved stabilization of the ankle in inversion. Those performed with elastic material secondarily facilitated eversion. The lateral subtalar sling taping (34) and the ankle balance tape (42, 55) were not included in these groups because of their low location. In addition, numerous studies stabilized the tibioperoneal joint with some active taping and/or eversion. Among the techniques combined with rigid taping, standard active straps such as 'double figure 6 and a single medial heel-lock' (35, 54) were found.

## Outcomes of included studies

The results of the analyzed studies are shown schematically in Table 4, distinguishing the following variables: significant, partially significant (i.e. at least one variable was significant) and not significant. Given the great heterogeneity of the variables, they were grouped by the similarity of their characteristics. All statistically significant differences found between interventions and nonintervention/placebo were not in favor of the intervention.

In summary, the frequency at which the most evaluated variables are analyzed is shown in Fig. 3.

## Meta-analytic results

Four separate meta-analyses were performed due to the variability of the studies. The results of the variables are shown here. Supplementary Table 2 shows descriptive data.

Meta-analyses 1 and 2: They included Chou *et al.* (37) and Grindstaff *et al.* (40). The variables *h/M* ratio soleus and *h/M* ratio peroneus were analyzed (h-reflex/M-response) requiring voluntary isometric plantar flexion contractions with a fibular reposition taping (FRT) with rigid tape. The main results are shown in the Table 5, the overall in the Table 6 and its representation in Fig. 4.

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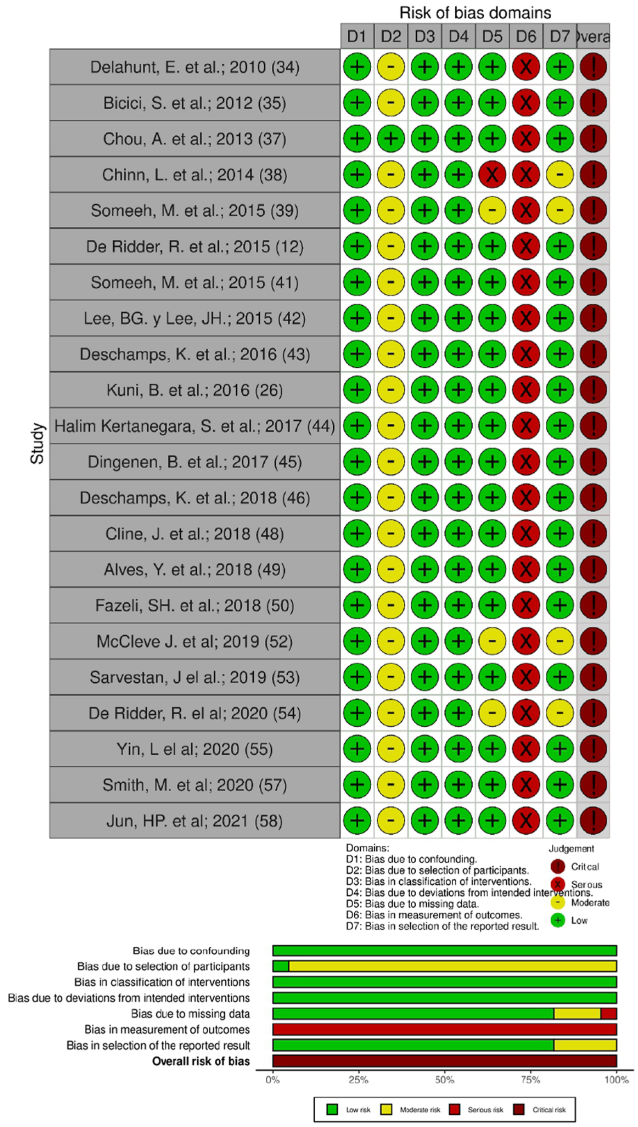


**Figure 2**

ROBINS-I quality assessment.

Meta-analyses 3 and 4: They studied the effectiveness of functional taping techniques FRT with rigid tape, similar standard/combined with rigid tape, and combined KT (subgroups of meta-analyses based on groupings in the previous qualitative analysis); in dynamic balance, assessed with SEBT or modified SEBT (mSEBT). The meta-analyses considered, on the one hand, the variable 'mSEBT', i.e. sum of the three directions including anterior, posteromedial, and posterolateral (34, 35, 36, 48, 56); and on the other hand, the 'posteromedial' (PM) variable in isolation (34, 35, 36, 41, 48, 56) due to being the most analyzed. The main results are shown in Table 7, the overall in Table 8, and its representation in Fig. 5. The ES are represented by a radar chart (Fig. 6).

## Discussion

The systematic review addresses the analysis of biomechanical/functional bandages and their effectiveness in CAI based on experimental and preexperimental studies. It focuses on the characteristics of participants, the interventions, the variables, the assessment tools used and the results obtained. The elastic (standard material or kinesiotape) and inelastic functional bandages used biomechanically provided beneficial clinical effects in CAI. Improvements were observed in all the groups of variables analyzed, but with different levels of effectiveness. The variables regarding PROMs, static balance, dynamic balance, kinematics, and scores obtained by agility and motor control tests stood out both due to their effectiveness and the amount of evidence found. The quantitative analyses showed no significant statistical differences. However, clinically they were slightly favorable when applying FRT with rigid tape in relation to the variables: (i) *h/M* ratio soleus during plantar flexor muscle contraction and (ii) dynamic balance during mSEBT or when performing only posteromedial direction.

As for the definition of CAI, there is some controversy. Some authors (13, 14, 15) differentiated the deficits of mechanical instability and functional instability; and others (19) indicated that both issues should appear simultaneously for chronic instability to exist. We consider that functional instability encompasses mechanical instability, according to Hertel *et al.* (20) and Bicici *et al.* (35).

The variables linked with dynamic balance and kinematics were the most addressed, followed by static balance and PROMs. The spatiotemporal variables of gait, the subjective sensation of patients and muscle activation were highlighted by their clinical relevance.

Deficits in static and dynamic balance (postural control) are present in CAI, due to the alteration of proprioception and neuromuscular control (59). According to Han *et al.* (60), we considered that proprioception and balance are an indivisible entity.

Static balance was considered in 28.57% of the studies and dynamic balance in 42.85%, obtaining significant results in 87.5% of the assessments and 66.66% respectively. The good results showed by both inelastic and elastic functional bandages in dynamic balance may be related to their proprioceptive effect when stimulating the skin mechanoreceptors (61, 62), decreasing the recurrences in ankle sprains (12).

The meta-analyses regarding dynamic balance found no significant statistical differences when considering the three types of bandages grouped in the qualitative analysis together (FRT with rigid tape, standard/similar combination rigid tape, and combined KT) or separately,

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**Table 2** Classification according to gender, physical activity, and scales used for inclusion criteria.

| Classification | References |
|---|---|
| Gender | |
| Homogeneous (men/women) | 12, 18, 26, 43, 44, 45, 46, 47, 49, 50, 51, 53, 54, 57, 34, 36, 37, 38, 39, 40, 41 |
| Only men | 35, 42, 55, 58 |
| Not specified | 48, 52, 56 |
| Physical activity | |
| Specific sport* | 34, 35, 39, 40, 43, 45, 48, 56 |
| Active people | 12, 36, 37, 41, 46, 49, 50, 57 |
| Not specified | 18, 26, 38, 42, 44, 47, 51, 53, 54, 55, 58 |
| No participants | 52 |
| Functional scales | |
| CAIT | 18, 34, 35, 42, 43, 44, 45, 47, 49, 51, 54, 55, 56, 58 |
| FAAM | 37, 40, 57, 58 |
| FAAM-Sport | 36, 37, 38, 52, 57, 58 |
| FADI and FADI-Sport | 39, 41, 46, 50†, 54 |
| IdFAI | 48, 52 |
| AII | 40 |
| No scale | 12, 26, 53 |

*Soccer, athletics, volleyball, handball, and basketball; †This study used only FADI.
AII, Ankle Instability Instrument; CAIT, Cumberland Ankle Instability Tool; FAAM, Foot and Ankle Ability Measure; FADI, Foot and Ankle Disability Index; IdFAI, Identification of Functional Ankle Instability.

**Table 3** Bandage techniques and materials.

| Materials/techniques | References |
|---|---|
| Interventions using biomechanical bandages | |
| Adhesive elastic bandages: kinesiotape | 18, 26, 35, 42, 48, 51, 53, 55, 56, 58 |
| Standard adhesive elastic bandages | 47 |
| Inelastic bandages with tape | 12, 26, 34, 35, 36, 37, 38, 39, 40, 41, 43, 44, 45, 46, 48, 49, 50, 51, 52, 53, 54, 55, 57, 58 |
| Techniques | |
| Combination technique with kinesiotape | 18, 26, 35, 48, 51, 53, 56, 58 |
| Standard or similar technique with rigid tape | 12, 26, 35, 38, 43, 44, 45, 46, 48, 51, 53, 54, 58 |
| FRT/Mulligan with rigid tape | 34, 36, 37, 39, 40, 41, 49, 50, 52, 57, 58 |
| Lateral subtalar sling taping | 34 |
| Ankle balance tape | 42, 55 |
| Time of posttest assessment | |
| Immediately | 12, 18, 26, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 54, 55, 57, 58 |
| Immediately + after 7 days of use | 18, 47 |
| After 4-week intervention period | 56 |
| Not specified | 53 |

FRT, fibular reposition taping.

assessed with mSEBT (34, 35, 36, 48, 56) or with isolated PM direction (34, 35, 36, 41, 48, 56); according to the obtained values of 95% CI (spanning 0) and $P > 0.05$. However, the $Z$ value was far from 0 in FRT for PM ($Z = -0.215$), obtaining the lowest ES (−0.064); and in KT for mSEBT ($Z = 0.330$) with the highest ES (0.057). The overall value of mSEBT with all bandaging techniques were considered slightly more favorable than those of PM, with ES −0.006 and 0.035, respectively.

In general, from a clinical perspective, meta-analyses found a slight effectiveness in the application of combined KT, a result supported especially by the weight of Hadadi's study (56). KT found greater benefits possibly because it stabilizes adequately but without the stiffness of rigid tape that limits the ROM needed to advance the healthy limb in all directions of the SEBT. Also, KT stimulates the muscles antagonistic of the instability by its elastic effect, facilitating the user's ability to react during dynamic balancing and offering safety. Even so, we must be cautious with the results since each SEBT execution implies small modifications (up or down) in the length reached, independently of the application or not of bandages, fatigue, or any other inclusive factor. Therefore, large samples are recommended and/or the use of meta-analyses.

Moreover, it seems reasonable that the increase in the distance to be reached with the swinging lower limb was small when applying tape, since balance or proprioception of the supporting (affected) ankle is not the only factor that influences the test results. Regarding the swinging lower limb, the ROM of the hip, the elasticity of the rectus anterior quadriceps and psoas iliacus when the movements are posteriorward, or of the abductor muscles in abductions, among other factors, could also be influential. Regarding the supporting lower limb, the resistance to quadriceps muscle fatigue is another factor to take into account.

Kinematics was evaluated in 42.85% of the studies, obtaining 75.00% effectiveness. Subjects with CAI presented alterations in ankle mobility while walking, greater inversion and lower dorsiflexion. This lead to erroneous biomechanical movements and abnormal or inappropriate statics (43). Ankle functional bandages decrease pathological ROM to improve stability. Therefore, this procedure is effective in reducing recurrences of sprains due to its effect of correcting the ankle joint position (43).

Mechanical effect is possible with elastic and inelastic bandages. Applied pressure and consistency of the material will imply a greater or lesser effect on joint fixation (63), i.e. the adhesive elastic bandage using KT will be the one with the least consistency. Besides, the mechanical effect of the KT is not exclusively due to the power of its joint stabilizing effect, but it can also enable traction for the correction or alignment of the segment, in this case of the ankle and foot.

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**Table 4** Significance of the analyzed variables.

| | **SB*** | **DB**** | **KM** (° or mm)*** | **Perception levels**‡ | **Scores**⁋ | **Vertical jump** (cm) | **Strength**‡‡ | **MA** (EMG) | **STG** | **Stair descent** | **PE** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Delahunt *et al.* (34) | | NS | | PS | | | | | | | |
| Bicici *et al.* (35) | PS | NS | | | PS | PS | PS | | | | |
| Wheeler *et al.* (36) | | PS | NS | | | | | | | | |
| Chou *et al.* (37) | | | | | | | | PS | | | |
| Chinn *et al.* (38) | | | S | | | | | | | | |
| Someeh *et al.* (39) | | | | S | S | | | | | | |
| De Ridder *et al.* (12) | | NS | PS | PS | | | | | | | |
| Grindstaff *et al.* (40) | | | | | | | | NS | | | |
| Someeh *et al.* (41) | | S | | | | | | | | | |
| Lee and Lee (42) | | PS | | | | | | | | | |
| De la Torre Domingo *et al.* (18) | PS | PS | | | | | | | | | |
| Deschamps *et al.* (43) | | | PS | | | | | | PS | | |
| Kuni *et al.* (26) | | | PS | | | | | | | | |
| Halim-Kertanegara *et al.* (44) | | NS | | PS | PS | | | | | S | |
| Dingenen *et al.* (45) | | | PS | | | | | | NS | | |
| Deschamps *et al.* (46) | | | PS | | | | | | PS | | |
| Alguacil-Diego *et al.* (47) | PS | PS | | | | | | | | | |
| Cline *et al.* (48) | NS | PS | | S | | | | | | | |
| Alves *et al.* (49) | PS | | | | PS | | | PS | | | PS |
| Fazeli *et al.* (50) | PS | | | | | | | | | | |
| Yen *et al.* (51) | | | PS | | | | | | | | |
| McCleve *et al.* (52) | | | NS | NS | | | | | | | |
| Sarvestan *et al.* (53) | | | | | PS | | | | | | |
| De Ridder *et al.* (54) | | | S | | | | | | | | |
| Yin *et al.* (55) | PS | PS | | S | | | | | | | |
| Haddadi *et al.* (56) | S | S | | S | S | | | | | | |
| Smith *et al.* (57) | | | PS | S | | | | | | | |
| Jun *et al.* (58) | | | NS | | | | | | | | |
| Total | 8 | 12 | 12 | 9 | 6 | 1 | 1 | 3 | 3 | 1 | 1 |

*Static balance includes: strategies used (horizontal force or vertical). Values: time to boundary, center of pressure (COP), standard deviation (COPsd), COP velocity, COP area, total distance, speed, displacements, mean displacement (mdCOP), rangeCOP, average speed (velCOP) in anteroposterior and mediolateral directions; **Dynamic balance by running, jumps, turns, horizontal force or vertical, etc.; ***ROM under load/unload, ankle subtalar joint, dorsiflex in loading, rearfoot excursion in inversion/eversion, joint angular position, joint angular velocity, etc.; ‡Perception of stability, confidence, reassurance, level of difficulty, comfort; ⁋Scores of agility and motor control tests by functional performance; ‡‡Isotonic endurance of plantar flexors, touch down in landing (jump);
DB, dynamic balance (control postural); KM, kinematics of ankle, knee, hip; joint angular position, joint angular velocity; MA, muscle activity; NS, nonsignificant; PE, physical effort, endurance; PS, partially significant. At least one variable was significant; S, significant; SB, static balance (control postural); STG, spatiotemporal gait variables.

The interventions that addressed the effect of bandages on kinematics mainly used inelastic bandages (12, 26, 34, 35, 36, 37, 38, 39, 40, 41, 43, 44, 45, 46, 48, 49, 50, 51, 52, 53, 54, 55, 57, 58), probably due to their lower capacity of deformation in relation to elastic bandages, which provide greater stability to the joint (63). Although in the analyzed studies inelastic bandages were the most used to modify the joint position of the ankle, both methods obtained positive results. Two studies (26, 53) performed a comparison between the effectiveness of elastic and inelastic bandages, obtaining better results with inelastic bandages.

The spatiotemporal variables of gait were only assessed in 10.71% of the studies (43, 45, 46), although gait is one of the functions associated with quality of human life (64). Bandage interventions found 66.6% of effectiveness. According to Punt *et al.* (65), subjects without any physiotherapy treatment 4 weeks after a sprained ankle presented alterations in gait: lower speed, shorter step length, shorter monopodal support time, and reduced and delayed plantar flexion. Mechanical functional bandage improves certain spatial–temporal variables. Deschamps *et al.* (43, 46) normalized gait speed and stride time, while Punt (65) did not find any significant differences in the rest of the variables.

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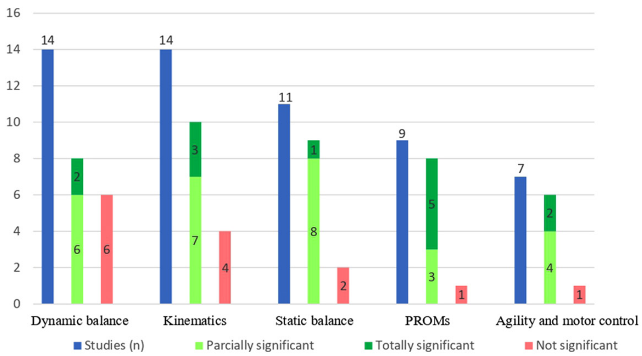


**Figure 3**

Frequency of appearance of grouped variables. The variables analyzed sporadically are not shown.

The subjective feeling of the patient was highlighted both for its clinical relevance and for the vast evidence found in this review. Many studies addressed perception using PROMs (32.14%), and 88.88% of them obtained significant and effective results. The perception of confidence and security with bandages can contribute to functional performance. Ankle bandages, even with placebo, reassured and gave participants confidence in the development of functional tasks (45), again justifying the usefulness of bandages in the clinical area (45).

Muscle activation was only analyzed in 10.71% of the studies (37, 40, 49), obtaining significant evidence of bandage effectiveness (37, 49). The soleus is a key muscle for balance, while the peroneus longus is the key muscle for the control of ankle inversion (40). Arthrogenic inhibition, i.e. the deficit in motor recruitment of the periarticular muscles, is common after a sprained ankle. Hence, such inhibition will hinder subsequent functional recovery. In fact, Chou *et al.* (37) proposed the inhibition of these muscles as a potential mechanism that would lead to dysfunction associated with CAI. Meta-analyses including Chou *et al.* (37) and Grindstaff *et al.* (40) found no statistically significant differences in *h/M* ratio soleus or *h/M* ratio peroneus with FRT of rigid tape during an isometric plantar flexion contraction based on the following values: 95% CI (spanning 0), $P > 0.05$ and $Z$ (close to 0). In both cases, the overall ES were similar, 0.080 and 0.070, respectively. Despite this, a slight improvement in the efficacy of *h/M* soleus was observed at a clinical level, supported exclusively by Chou (37), who recommended this method for spinal reflex excitability of soleus in CAI and, consequently, to decrease recurrences. On the other hand, Alves *et al.* (49) showed an improvement in peroneal latency time when comparing Mulligan taping, FRT, with placebo taping.

In relation to the inclusion criteria, all subjects with CAI were included in the same group, without considering this instability could vary. One of the most used tools at the time of identifying a subject with CAI and to measure the degree of severity was the CAIT. Those subjects who obtained a score under or equal to 27 points (maximum 30) were cataloged as CAI (51). However, not all the studies used this value as an inclusion criterion. Halim-Kertanegara *et al.* (44) considered that the subjects suffered instability if they had a score lower than 25 in CAIT, while Deschamps *et al.* (43) and Dingenen *et al.* (45) included them with a score under or equal to 24.

Although CAIT is a tool widely used as inclusion criterion, 14 of the 28 studies (18, 34, 35, 42, 43, 44, 45, 47, 49, 51, 54, 55, 56, 58) did not apply it as a posttest to evaluate whether the intervention caused changes in the score of that scale. This may be related to the fact that the effect of bandages was evaluated immediately after application in these studies, aside from 2 (18, 47). Hence, similar studies to those by De la Torre *et al.* (18) and Alguacil *et al.* (47) should be carried out regarding the changes that bandages produce after a certain period of application. Further studies could also focus on the long-term results following the

**Table 5** Main results of the meta-analyses 1 and 2.

| Study | *n* | Effect size | s.e. | 95% CI | *Z* | *P* |
|---|---|---|---|---|---|---|
| *h/M* ratio soleus | | | | | | |
| Chou *et al.* (37) | 15 | 0.164 | 3.876 | −7.431, 7.760 | 0.042 | 0.966 |
| Grindstaff *et al.* (40) | 23 | 0 | 3.773 | −7.395, 7.395 | 0 | >0.999 |
| *h/M* ratio peroneus | | | | | | |
| Chou *et al.* (37) | 15 | 0.048 | 4.957 | −9.668, 9.763 | 0.010 | 0.992 |
| Grindstaff *et al.* (40) | 23 | 0.085 | 4.132 | −8.013, 8.184 | 0.021 | 0.984 |

**Table 6** Meta-analysis of variables *h/M* ratio soleus and *h/M* ratio peroneus.

| | Effect size | s.e. | 95% CI | *Z* | *P* | $H^2$ | $I^2$ |
|---|---|---|---|---|---|---|---|
| *h/M* ratio soleus | 0.080 | 2.704 | −5.219, 5.379 | 0.030 | 0.976 | 0.001 | 0 |
| *h/M* ratio peroneus | 0.070 | 3.174 | −6.151, 6.291 | 0.022 | 0.982 | 0 | 0 |

$H^2$ and $I^2$ were used for heterogeneity.

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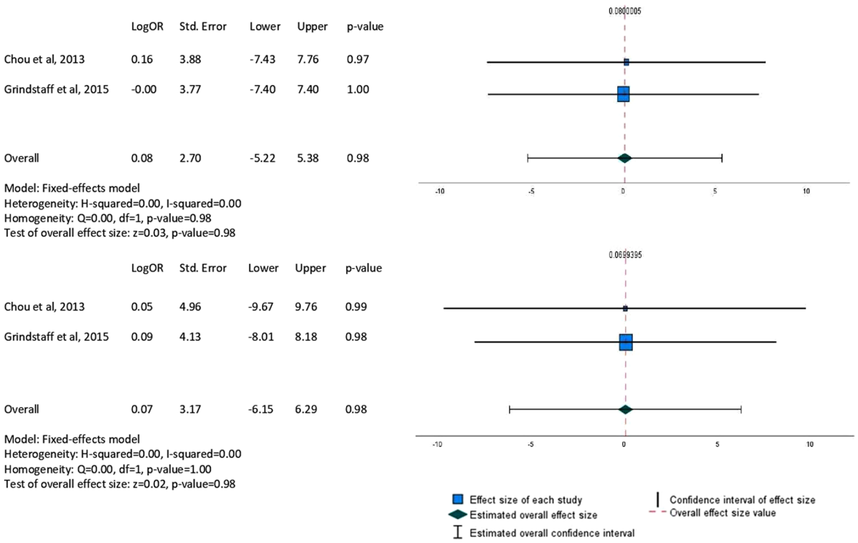


**Figure 4**

Forest plot representing the meta-analysis of variables *h/M* ratio soleus (first) and *h/M* ratio peroneus (second).

**Table 7** Main results of the meta-analyses 3 and 4.

| Study | Bandage techniques | *n* | Effect size | S.E. | 95% CI | *Z* | *P* |
|---|---|---|---|---|---|---|---|
| PM direction of mSEBT | | | | | | | |
| Delahunt *et al.* (34) | FRT | 16 | −0.126 | 0.482 | −1.017, 0.819 | −0.261 | 0.794 |
| Someeh *et al.* (41) | FRT | 16 | −0.088 | 0.529 | −1.124, 0.949 | −0.166 | 0.868 |
| Wheeler *et al.* (36) | FRT | 23 | 0.039 | 0.542 | −1.024, 1.102 | 0.072 | 0.942 |
| Bicici *et al.* (35) | Rigid tape | 15 | 0.071 | 0.527 | −0.962, 1.103 | 0.134 | 0.893 |
| Cline *et al.* (48) | Rigid tape | 24 | −0.047 | 0.441 | −0.912, 0.818 | −0.106 | 0.915 |
| Bicici *et al.* (35) | KT | 15 | 0.091 | 0.529 | −0.945, 1.128 | 0.173 | 0.863 |
| Cline *et al.* (48) | KT | 24 | −0.072 | 0.472 | −0.996, 0.852 | −0.153 | 0.879 |
| Haddadi *et al.* (56) | KT | 13 | 0.120 | 0.480 | −0.820, 1.059 | 0.249 | 0.803 |
| All directions of mSEBT | | | | | | | |
| Delahunt *et al.* (34) | FRT | 16 | −0.010 | 0.306 | −0.609, 0.590 | −0.031 | 0.975 |
| Wheeler *et al.* (36) | FRT | 23 | 0.037 | 0.319 | −0.587, 0.662 | 0.117 | 0.907 |
| Bicici *et al.* (35) | Rigid tape | 15 | 0.050 | 0.338 | −0.613, 0.712 | 0.147 | 0.883 |
| Cline *et al.* (48) | Rigid tape | 24 | 0.002 | 0.276 | −0.539, 0.543 | 0.008 | 0.994 |
| Bicici *et al.* (35) | KT | 15 | 0.029 | 0.336 | −0.631, 0.688 | 0.085 | 0.932 |
| Cline *et al.* (48) | KT | 24 | 0.022 | 0.295 | −0.557, 0.601 | 0.076 | 0.940 |
| Haddadi *et al.* (56) | KT | 13 | 0.105 | 0.274 | −0.432, 0.643 | 0.384 | 0.701 |

FRT, fibular reposition taping; KT, kinesiotape; mSEBT, modified start excursion balance test; PM, posteromedial.

**Table 8** Meta-analysis of variables posteromedial direction of mSEBT and all directions of mSEBT.

| | Effect size | S.E. | 95% CI | *Z* | *P* | $H^2$ | 95% CI | $I^2$ | 95% CI |
|---|---|---|---|---|---|---|---|---|---|
| Posteromedial | | | | | | | | | |
| FRT | −0.064 | 0.298 | −0.648, 0.520 | −0.215 | 0.830 | 0.027 | 0.003–0.262 | 0 | 0–0 |
| RT | 0.002 | 0.338 | −0.661, 0.665 | 0.005 | 0.996 | 0.029 | – | – | – |
| KT | 0.042 | 0.284 | −0.514, 0.598 | 0.148 | 0.882 | 0.047 | 0.005–0.448 | 0 | 0–0 |
| Overall | −0.006 | 0.482 | −1.071, 0.819 | −0.261 | 0.794 | 0.035 | 0.011–0.108 | 0 | 0–0 |
| mSEBT | | | | | | | | | |
| FRT | 0.013 | 0.221 | −0.419; 0.445 | 0.059 | 0.953 | 0.011 | – | 0 | 0–0 |
| RT | 0.021 | 0.214 | −0.398; 0.440 | 0.099 | 0.921 | 0.012 | – | – | – |
| KT | 0.057 | 0.173 | −0.281; 0.395 | 0.330 | 0.742 | 0.026 | 0.003–0.250 | 0 | 0–0 |
| Overall | 0.035 | 0.115 | −0.190; 0.590 | −0.031 | 0.762 | 0.018 | 0.005–0.060 | 0 | 0–0 |

$H^2$ and $I^2$ were used for heterogeneity.
FRT, fibular reposition taping; RT, rigid tape; KT, kinesiotape; mSEBT, modified star excursion balance test.

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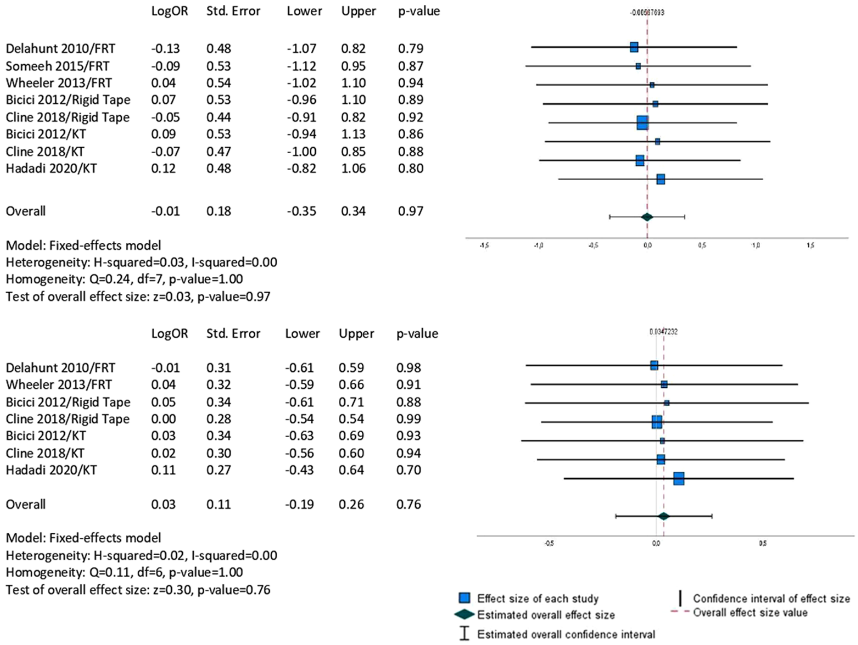

| | LogOR | Std. Error | Lower | Upper | p-value |
|---|---|---|---|---|---|
| Delahunt 2010/FRT | -0.13 | 0.48 | -1.07 | 0.82 | 0.79 |
| Someeh 2015/FRT | -0.09 | 0.53 | -1.12 | 0.95 | 0.87 |
| Wheeler 2013/FRT | 0.04 | 0.54 | -1.02 | 1.10 | 0.94 |
| Bicici 2012/Rigid Tape | 0.07 | 0.53 | -0.96 | 1.10 | 0.89 |
| Cline 2018/Rigid Tape | -0.05 | 0.44 | -0.91 | 0.82 | 0.92 |
| Bicici 2012/KT | 0.09 | 0.53 | -0.94 | 1.13 | 0.86 |
| Cline 2018/KT | -0.07 | 0.47 | -1.00 | 0.85 | 0.88 |
| Hadadi 2020/KT | 0.12 | 0.48 | -0.82 | 1.06 | 0.80 |
| Overall | -0.01 | 0.18 | -0.35 | 0.34 | 0.97 |

Model: Fixed-effects model
Heterogeneity: H-squared=0.03, I-squared=0.00
Homogeneity: Q=0.24, df=7, p-value=1.00
Test of overall effect size: z=0.03, p-value=0.97

| | LogOR | Std. Error | Lower | Upper | p-value |
|---|---|---|---|---|---|
| Delahunt 2010/FRT | -0.01 | 0.31 | -0.61 | 0.59 | 0.98 |
| Wheeler 2013/FRT | 0.04 | 0.32 | -0.59 | 0.66 | 0.91 |
| Bicici 2012/Rigid Tape | 0.05 | 0.34 | -0.61 | 0.71 | 0.88 |
| Cline 2018/Rigid Tape | 0.00 | 0.28 | -0.54 | 0.54 | 0.99 |
| Bicici 2012/KT | 0.03 | 0.34 | -0.63 | 0.69 | 0.93 |
| Cline 2018/KT | 0.02 | 0.30 | -0.56 | 0.60 | 0.94 |
| Hadadi 2020/KT | 0.11 | 0.27 | -0.43 | 0.64 | 0.70 |
| Overall | 0.03 | 0.11 | -0.19 | 0.26 | 0.76 |

Model: Fixed-effects model
Heterogeneity: H-squared=0.02, I-squared=0.00
Homogeneity: Q=0.11, df=6, p-value=1.00
Test of overall effect size: z=0.30, p-value=0.76



**Figure 5**

Forest plot representing the meta-analysis of variables posteromedial direction of mSEBT (first) and all directions of mSEBT (second). FRT, fibular reposition taping; KT, kinesiotape.

removal of bandages. According to Jackson *et al.* (66), KT in particular should be kept on for at least 48 h, also noting that one of the reasons why some investigations did not find improvements in balance was because subjects wore the bandage for a short time.

Regarding the strengths of the review, the quality of the study is evident by having followed the PRISMA protocol exhaustively. In addition, data extraction was agreed upon by three reviewers. In relation to the methodological quality of the selected articles, it was analyzed using the PEDro scale for the randomized studies and all of them obtained a methodological quality ranging from good to high. ROBINS-I was used for nonrandomized ones, and they showed a serious risk of bias in dimension 6 (measurements of outcomes). This result may be due to the impossibility of blinding the physiotherapist who applies the bandage. In addition, the participant may be conditioned by the comparison with the nonintervention.

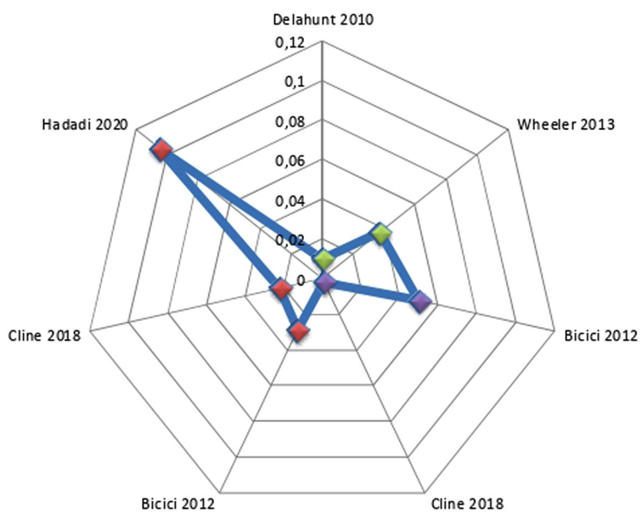


**Figure 6**

Radar chart representing the size effects including all directions of mSEBT. Green, fibular reposition taping; purple, rigid tape; red, kinesiotape.

On the other hand, sometimes the variability of the selected studies, regarding the materials used, the bandage application techniques, some noncomparable assessment tools or units of measurement, standardized or nonstandardized data showed, the time of posttest assessments and the variables analyzed, could be considered limitations in carrying out a general meta-analysis. Nevertheless, this review included four separate meta-analyses complementing the qualitative analysis.

## Conclusions

This systematic review showed that biomechanical or functional bandages, whether elastic or inelastic, applied in subjects with CAI found effectiveness in all the groups of variables analyzed, although patient perception by PROMs, static balance, dynamic balance, kinematics, and scores by agility and motor control stood out for their level of effectiveness and amount of evidence. As a result, bandages produced an increase in ankle functionality.

Both bandages, elastic and inelastic, achieved an improvement in the correction of the pathological joint position.

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The meta-analyses regarding dynamic balance, did not find significant statistical differences in the groups with fibular reposition taping with rigid tape, standard/similar combination techniques with rigid tape and combination techniques with kinesiotaping; in combination or separately, being assessed with mSEBT or only with the posteromedial direction. In general, from a clinical perspective, the meta-analyses found a slight effectiveness in the application of combined kinesiotaping, a result to be considered with caution. The meta-analyses regarding *h/M* ratio soleus or *h/M* peroneus with fibular reposition taping with rigid tape during an isometric plantar flexion contraction found no statistical difference. Clinically, a slight improvement in the efficacy of *h/M* soleus was determined, recommending the spinal reflex excitability of soleus in CAI, thus improving balance and minimizing recurrences.

The lack of clinical trials analyzing the effectiveness of biomechanical bandages on gait, muscle activation, and BADLs, despite their clinical relevance, suggests the need for generation of further compelling evidence.

Thus, functional bandages are feasible and effective tools in daily clinical practice for subjects with chronic ankle instability.

**Supplementary materials**

This is linked to the online version of the paper at https://doi.org/10.1530/EOR-23-0129.

**ICMJE Conflict of Interest Statement**

The authors declare that there is no conflict of interest that could be perceived as prejudicing the impartiality of the work reported here.

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**Author contribution statement**

GC conceptualized the idea. VP and MB carried out the study selection and data extraction. GC and VP carried out the manuscript drafting. GC, VP, and MB were involved in critically revising for important intellectual contents. All authors contributed to the final version and approved the final version of the manuscript.

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## References

1 Rozzi SL, Lephart SM, Sterner R & Kuligowski L. Balance training for persons with functionally unstable ankles. *Journal of Orthopaedic and Sports Physical Therapy* 1999 **29** 478–486. (https://doi.org/10.2519/jospt.1999.29.8.478)

2 Roos KG, Kerr ZY, Mauntel TC, Djoko A, Dompier TP & Wikstrom EA. The epidemiology of lateral ligament complex ankle sprains in National Collegiate Athletic Association sports. *American Journal of Sports Medicine* 2017 **45** 201–209. (https://doi.org/10.1177/0363546516660980)

3 Lin CC, Chen SJ, Lee WC & Lin CF. Effects of different ankle supports on the single-leg lateral drop landing following muscle fatigue in athletes with functional ankle instability. *International Journal of Environmental Research and Public Health* 2020 **17**. (https://doi.org/10.3390/ijerph17103438)

4 Herzog MM, Kerr ZY, Marshall SW & Wikstrom EA. Epidemiology of ankle sprains and chronic ankle instability. *Journal of Athletic Training* 2019 **54** 603–610. (https://doi.org/10.4085/1062-6050-447-17)

5 Gulbrandsen M, Hartigan DE, Patel KA, Makovicka JL, Tummala SV & Chhabra A. Ten-year epidemiology of ankle injuries in Men's and women's collegiate soccer players. *Journal of Athletic Training* 2019 **54** 881–888. (https://doi.org/10.4085/1062-6050-144-18)

6 Garrick JG. The frequency of injury, mechanism of injury, and epidemiology of ankle sprains. *American Journal of Sports Medicine* 1977 **5** 241–242. (https://doi.org/10.1177/036354657700500606)

7 Hølmer P, Søndergaard L, Konradsen L, Nielsen PT & Jørgensen LN. Epidemiology of sprains in the lateral ankle and foot. *Foot and Ankle International* 1994 **15** 72–74. (https://doi.org/10.1177/107110079401500204)

8 Ferran NA & Maffulli N. Epidemiology of sprains of the lateral ankle ligament complex. *Foot and Ankle Clinics* 2006 **11** 659–662. (https://doi.org/10.1016/j.fcl.2006.07.002)

9 Gribble PA, Bleakley CM, Caulfield BM, Docherty CL, Fourchet F, Fong DTP, Hertel J, Hiller CE, Kaminski TW, McKeon PO, *et al.* Evidence review for the 2016 International Ankle Consortium consensus statement on the prevalence, impact and long-term consequences of lateral ankle sprains. *British Journal of Sports Medicine* 2016 **50** 1496–1505. (https://doi.org/10.1136/bjsports-2016-096189)

10 Doherty C, Bleakley C, Hertel J, Caulfield B, Ryan J & Delahunt E. Recovery from a first-time lateral ankle sprain and the predictors of chronic ankle instability: a Prospective Cohort Analysis. *American Journal of Sports Medicine* 2016 **44** 995–1003. (https://doi.org/10.1177/0363546516628870)

11 Konradsen L, Bech L, Ehrenbjerg M & Nickelsen T. Seven years follow-up after ankle inversion trauma. *Scandinavian Journal of Medicine and Science in Sports* 2002 **12** 129–135. (https://doi.org/10.1034/j.1600-0838.2002.02104.x)

12 De Ridder R, Willems TM, Vanrenterghem J & Roosen P. Effect of tape on dynamic postural stability in subjects with chronic ankle instability. *International Journal of Sports Medicine* 2015 **36** 321–326. (https://doi.org/10.1055/s-0034-1385884)

13 Hertel J. Functional anatomy, pathomechanics, and pathophysiology of lateral ankle instability. *Journal of Athletic Training* 2002 **37** 364–375.

14 Van Rijn RM, van Os AG, Bernsen RMD, Luijsterburg PA, Koes BW & Bierma-Zeinstra SMA. What is the clinical course of acute ankle sprains? A systematic literature review. *American Journal of Medicine* 2008 **121** 324–331.e6. (https://doi.org/10.1016/j.amjmed.2007.11.018)

15 Attenborough AS, Hiller CE, Smith RM, Stuelcken M, Greene A & Sinclair PJ. Chronic ankle instability in sporting populations. *Sports Medicine* 2014 **44** 1545–1556. (https://doi.org/10.1007/s40279-014-0218-2)

16 Basnett CR, Hanish MJ, Wheeler TJ, Miriovsky DJ, Danielson EL, Barr JB & Grindstaff TL. Ankle dorsiflexion range of motion influences dynamic balance in individuals with chronic ankle instability. *International Journal of Sports Physical Therapy* 2013 **8** 121–128.

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https://doi.org/10.1530/EOR-23-0129

17 Gigi R, Haim A, Luger E, Segal G, Melamed E, Beer Y, Nof M, Nyska M & Elbaz A. Deviations in gait metrics in patients with chronic ankle instability: a case control study. *Journal of Foot and Ankle Research* 2015 **8** 1. (https://doi.org/10.1186/s13047-014-0058-1)

18 de-la-Torre-Domingo C, Alguacil-Diego IM, Molina-Rueda F, López-Román A & Fernández-Carnero J. Effect of kinesiology tape on measurements of balance in subjects with chronic ankle instability: a randomized controlled trial. *Archives of Physical Medicine and Rehabilitation* 2015 **96** 2169–2175. (https://doi.org/10.1016/j.apmr.2015.06.022)

19 Holmes A & Delahunt E. Treatment of common deficits associated with chronic ankle instability. *Sports Medicine* 2009 **39** 207–224. (https://doi.org/10.2165/00007256-200939030-00003)

20 Hertel J. Functional instability following lateral ankle sprain. *Sports Medicine* 2000 **29** 361–371. (https://doi.org/10.2165/00007256-200029050-00005)

21 McKeon PO & Donovan L. A perceptual framework for conservative treatment and rehabilitation of ankle sprains: an evidence-based paradigm shift. *Journal of Athletic Training* 2019 **54** 628–638. (https://doi.org/10.4085/1062-6050-474-17)

22 De Ridder R, Willems TM, Vanrenterghem J & Roosen P. Effect of a home-based balance training protocol on dynamic postural control in subjects with chronic ankle instability. *International Journal of Sports Medicine* 2015 **36** 596–602. (https://doi.org/10.1055/s-0034-1396823)

23 Hale SA, Fergus A, Axmacher R & Kiser K. Bilateral improvements in lower extremity function after unilateral balance training in individuals with chronic ankle instability. *Journal of Athletic Training* 2014 **49** 181–191. (https://doi.org/10.4085/1062-6050-49.2.06)

24 Eils E & Rosenbaum D. A multi-station proprioceptive exercise program in patients with ankle instability. *Medicine and Science in Sports and Exercise* 2001 **33** 1991–1998. (https://doi.org/10.1097/00005768-200112000-00003)

25 Hall EA, Docherty CL, Simon J, Kingma JJ & Klossner JC. Strength-training protocols to improve deficits in participants with chronic ankle instability: a randomized controlled trial. *Journal of Athletic Training* 2015 **50** 36–44. (https://doi.org/10.4085/1062-6050-49.3.71)

26 Kuni B, Mussler J, Kalkum E, Schmitt H & Wolf SI. Effect of kinesiotaping, non-elastic taping and bracing on segmental foot kinematics during drop landing in healthy subjects and subjects with chronic ankle instability. *Physiotherapy* 2016 **102** 287–293. (https://doi.org/10.1016/j.physio.2015.07.004)

27 Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, Shamseer L, Tetzlaff JM, Akl EA, Brennan SE, *et al.* The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ* 2021 **372** n71. (https://doi.org/10.1136/bmj.n71)

28 Sherrington C, Herbert RD, Maher CG & Moseley AM. PEDro. A database of randomized trials and systematic reviews in physiotherapy. *Manual Therapy* 2000 **5** 223–226. (https://doi.org/10.1054/math.2000.0372)

29 Maher CG, Sherrington C, Herbert RD, Moseley AM & Elkins M. Reliability of the PEDro scale for rating quality of randomized controlled trials. *Physical Therapy* 2003 **83** 713–721. (https://doi.org/10.1093/ptj/83.8.713)

30 De Morton NA. The PEDro scale is a valid measure of the methodological quality of clinical trials: a demographic study. *Australian Journal of Physiotherapy* 2009 **55** 129–133. (https://doi.org/10.1016/S0004-9514(09)70043-1)

31 Moseley AM, Herbert RD, Sherrington C & Maher CG. Evidence for physiotherapy practice: A survey of the Physiotherapy Evidence Database (PEDro). *Australian Journal of Physiotherapy* 2002 **48** 43–49. (https://doi.org/10.1016/S0004-9514(14)60281-6)

32 Sterne JA, Hernán MA, Reeves BC, Savović J, Berkman ND, Viswanathan M, Henry D, Altman DG, Ansari MT, Boutron I, *et al.* Robins-I: a tool for assessing risk of bias in non-randomised studies of interventions. *BMJ* 2016 **355** i4919. (https://doi.org/10.1136/bmj.i4919)

33 Martín-Conejero A. How to understand a meta-analysis in a medical journal? *Angiologia* 2022 **74** 22–26. (https://doi.org/10.20960/angiologia.00376)

34 Delahunt E, McGrath A, Doran N & Coughlan GF. Effect of taping on actual and perceived dynamic postural stability in persons with chronic ankle instability. *Archives of Physical Medicine and Rehabilitation* 2010 **91** 1383–1389. (https://doi.org/10.1016/j.apmr.2010.06.023)

35 Bicici S, Karatas N & Baltaci G. Effect of athletic taping and kinesiotaping® on measurements of functional performance in basketball players with chronic inversion ankle sprains. *International Journal of Sports Physical Therapy* 2012 **7** 154–166.

36 Wheeler TJ, Basnett CR, Hanish MJ, Miriovsky DJ, Danielson EL, Barr JB, Threlkeld AJ & Grindstaff TL. Fibular taping does not influence ankle dorsiflexion range of motion or balance measures in individuals with chronic ankle instability. *Journal of Science and Medicine in Sport* 2013 **16** 488–492. (https://doi.org/10.1016/j.jsams.2013.02.012)

37 Chou E, Kim KM, Baker AG, Hertel J & Hart JM. Lower leg neuromuscular changes following fibular reposition taping in individuals with chronic ankle instability. *Manual Therapy* 2013 **18** 316–320. (https://doi.org/10.1016/j.math.2012.11.004)

38 Chinn L, Dicharry J, Hart JM, Saliba S, Wilder R & Hertel J. Gait kinematics after taping in participants with chronic ankle instability. *Journal of Athletic Training* 2014 **49** 322–330. (https://doi.org/10.4085/1062-6050-49.3.08)

39 Someeh M, Norasteh AA, Daneshmandi H & Asadi A. Influence of mulligan ankle taping on functional performance tests in healthy athletes and athletes with chronic ankle instability. T Turner, Ed. *International Journal of Athletic Therapy and Training* 2015 **20** 39–45. (https://doi.org/10.1123/ijatt.2014-0050)

40 Grindstaff TL, Hanish MJ, Wheeler TJ, Basnett CR, Miriovsky DJ, Danielson EL, Barr JB & Joseph Threlkeld A. Fibular taping does not alter lower extremity spinal reflex excitability in individuals with chronic ankle instability. *Journal of Electromyography and Kinesiology* 2015 **25** 253–259. (https://doi.org/10.1016/j.jelekin.2015.01.009)

41 Someeh M, Norasteh AA, Daneshmandi H & Asadi A. Immediate effects of Mulligan's fibular repositioning taping on postural control in athletes with and without chronic ankle instability. *Physical Therapy in Sport* 2015 **16** 135–139. (https://doi.org/10.1016/j.ptsp.2014.08.003)

42 Lee BG & Lee JH. Immediate effects of ankle balance taping with kinesiology tape on the dynamic balance of young players with functional ankle instability. *Technology and Health Care* 2015 **23** 333–341. (https://doi.org/10.3233/THC-150902)

43 Deschamps K, Dingenen B, Pans F, Van Bavel I, Matricali GA & Staes F. Effect of taping on foot kinematics in persons with chronic ankle instability. *Journal of Science and Medicine in Sport* 2016 **19** 541–546. (https://doi.org/10.1016/j.jsams.2015.07.015)

44 Halim-Kertanegara S, Raymond J, Hiller CE, Kilbreath SL & Refshauge KM. The effect of ankle taping on functional performance in participants with functional ankle instability. *Physical Therapy in Sport* 2017 **23** 162–167. (https://doi.org/10.1016/j.ptsp.2016.03.005)

45 Dingenen B, Deschamps K, Delchambre F, Van Peer E, Staes FF & Matricali GA. Effect of taping on multi-segmental foot kinematic patterns during walking in persons with chronic ankle instability. *Journal of Science and Medicine in Sport* 2017 **20** 835–840. (https://doi.org/10.1016/j.jsams.2017.04.004)

46 Deschamps K, Matricali GA, Dingenen B, De Boeck J, Bronselaer S & Staes F. Foot and ankle kinematics in chronic ankle instability subjects using a midfoot strike pattern when running, including influence of taping. *Clinical Biomechanics* 2018 **54** 1–7. (https://doi.org/10.1016/j.clinbiomech.2018.02.016)

47 Alguacil-Diego IM, de-la-Torre-Domingo C, López-Román A, Miangolarra-Page JC & Molina-Rueda F. Effect of elastic bandage on postural control in subjects with chronic ankle instability: a randomised clinical trial. *Disability and Rehabilitation* 2018 **40** 806–812. (https://doi.org/10.1080/09638288.2016.1276975)

48 Cline J, Thomas Fenwick A, Turner T, Arthur S & Wikstrom EA. Nonelastic and Kinesio Tex tapes improve perceived stability but not postural control in participants with chronic ankle instability. *International Journal of Athletic Therapy and Training* 2018 **23** 195–199. (https://doi.org/10.1123/ijatt.2017-0112)

49 Alves Y, Ribeiro F & Silva AG. Effect of fibular repositioning taping in adult basketball players with chronic ankle instability: a randomized, placebo-controlled, crossover trial. *Journal of Sports Medicine and Physical Fitness* 2018 **58** 1465–1473. (https://doi.org/10.23736/S0022-4707.17.07472-2)

50 Fazeli SH, Amiri A, Jamshidi AA, Sanjari MA, Bagheri R, Rahimi F & Akbari M. Effect of ankle taping on postural control measures during grasp and release task in patients with chronic ankle instability. *Journal of Back and Musculoskeletal Rehabilitation* 2018 **31** 881–887. (https://doi.org/10.3233/BMR-171067)

51 Yen SC, Folmar E, Friend KA, Wang YC & Chui KK. Effects of kinesiotaping and athletic taping on ankle kinematics during walking in individuals with chronic ankle instability: a pilot study. *Gait and Posture* 2018 **66** 118–123. (https://doi.org/10.1016/j.gaitpost.2018.08.034)

52 McCleve J, Donovan L, Ingersoll CD, Armstrong C & Glaviano NR. Fibular reposition taping does not change lower extremity biomechanics during gait in active adults with chronic ankle instability. *International Journal of Athletic Therapy and Training* 2019 **24** 122–128. (https://doi.org/10.1123/ijatt.2017-0091)

53 Sarvestan J & Svoboda Z. Acute effect of ankle Kinesio and athletic taping on ankle range of motion during various agility tests in athletes with chronic ankle sprain. *Journal of Sport Rehabilitation* 2020 **29** 527–532. (https://doi.org/10.1123/jsr.2018-0398)

54 De Ridder R, Willems T, Vanrenterghem J, Verrelst R, De Blaiser C & Roosen P. Taping benefits ankle joint landing kinematics in subjects with chronic ankle instability. *Journal of Sport Rehabilitation* 2020 **29** 162–167. (https://doi.org/10.1123/jsr.2018-0234)

55 Yin L & Wang L. Acute effect of kinesiology taping on postural stability in individuals with unilateral chronic ankle instability. *Frontiers in Physiology* 2020 **11** 192. (https://doi.org/10.3389/fphys.2020.00192)

56 Hadadi M, Haghighat F, Mohammadpour N & Sobhani S. Effects of Kinesiotape vs Soft and semirigid ankle orthoses on balance in patients with chronic ankle instability: A randomized controlled trial. *Foot and Ankle International* 2020 **41** 793–802. (https://doi.org/10.1177/1071100720917181)

57 Smith MD, Vitharana TN, Wallis GM & Vicenzino B. Response profile of fibular repositioning tape on ankle osteokinematics, arthrokinematics, perceived stability and confidence in chronic ankle instability. *Musculoskeletal Science and Practice* 2020 **50** 102272. (https://doi.org/10.1016/j.msksp.2020.102272)

58 Jun HP, Choi S & Chang E. Influence of prophylactic ankle tapes on lower-extremity kinematics during a stop-jump task in chronic ankle instability. *Journal of Men's Health* 2021 **17** 255–263. (https://doi.org/10.31083/jomh.2021.068)

59 Jaber H, Lohman E, Daher N, Bains G, Nagaraj A, Mayekar P, Shanbhag M & Alameri M. Neuromuscular control of ankle and hip during performance of the star excursion balance test in subjects with and without chronic ankle instability. *PLoS One* 2018 **13** e0201479. (https://doi.org/10.1371/journal.pone.0201479)

60 Han J, Anson J, Waddington G, Adams R & Liu Y. The role of ankle proprioception for balance control in relation to sports performance and injury. *BioMed Research International* 2015 **2015** 842804. (https://doi.org/10.1155/2015/842804)

61 Pathak P & Ahn J. Taping-induced cutaneous stimulation to the ankle tendons reduces minimum toe clearance variability. *Heliyon* 2023 **9** e12682. (https://doi.org/10.1016/j.heliyon.2022.e12682)

62 Simoneau GG, Degner RM, Kramper CA & Kittleson KH. Changes in ankle joint proprioception resulting from strips of athletic tape applied over the skin. *Journal of Athletic Training* 1997 **32** 141–147.

63 Trégouët P, Merland F & Horodyski MB. A comparison of the effects of ankle taping styles on biomechanics during ankle inversion. *Annals of Physical and Rehabilitation Medicine* 2013 **56** 113–122. (https://doi.org/10.1016/j.rehab.2012.12.001)

64 Lee I, Lee SY & Ha S. Alterations of lower extremity function, health-related quality of life, and spatiotemporal gait parameters among individuals with chronic ankle instability. *Physical Therapy in Sport* 2021 **51** 22–28. (https://doi.org/10.1016/j.ptsp.2021.06.006)

65 Punt IM, Ziltener JL, Laidet M, Armand S & Allet L. Gait and physical impairments in patients with acute ankle sprains who did not receive physical therapy. *PM and R* 2015 **7** 34–41. (https://doi.org/10.1016/j.pmrj.2014.06.014)

66 Jackson K, Simon JE & Docherty CL. Extended use of kinesiology tape and balance in participants with chronic ankle instability. *Journal of Athletic Training* 2016 **51** 16–21. (https://doi.org/10.4085/1062-6050-51.2.03)