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SYSTEMATIC REVIEW

# Effects of elastic kinesiology taping on shoulder proprioception: a systematic review

**Amanda L. Ager[a,b,*], Fabio Carlos Lucas de Oliveira[c], Jean-Sébastien Roy[a,d], Dorien Borms[b], Michiel Deraedt[b], Morgane Huyge[b], Arne Deschepper[b], Ann M. Cools[b]**

[a] *Center for Interdisciplinary Research in Rehabilitation and Social Integration, Rehabilitation Institute, Quebec City, QC, Canada*
[b] *Department of Rehabilitation Sciences and Physiotherapy, Faculty of Medicine and Health Sciences, Ghent University, Ghent, Belgium*
[c] *Research Unit in Sport and Physical Activity (CIDAF), Faculty of Sport Sciences and Physical Education, University of Coimbra, Coimbra, Portugal*
[d] *Department of Rehabilitation, Faculty of Medicine, Université Laval, Quebec City, QC, Canada*

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**KEYWORDS**
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Joint position sense;
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Shoulder;
Upper limbs

**Abstract**
*Background:* Shoulder injuries are associated with proprioceptive deficits. Elastic kinesiology tape (KT) is used for treating musculoskeletal disorders, including shoulder injuries, as it arguably improves proprioception.
*Objective:* To synthesize the evidence on the effects of elastic KT on proprioception in healthy and pathological shoulders.
*Methods:* Four databases (PubMed, WoS, CINAHL, SPORTDiscus) were searched for studies that investigated the effects of elastic KT on shoulder proprioception. Outcome measures were active joint position sense (AJPS), passive joint position sense (PJPS), kinesthesia, sense of force (SoF), and sense of velocity (SoV). Risk of bias (RoB) was assessed using the Cochrane Collaboration RoB tool for randomized controlled trials (RCTs), and the ROBINS-1 for non-RCTs, while the certainty of evidence was determined using GRADE.
*Results:* Eight studies (5 RCTs, 3 non-RCTs) were included, yielding 187 shoulders (102 healthy and 85 pathological shoulders). RoB ranged from low (2 studies), moderate (5 studies), to high (1 study). Elastic KT has a mixed effect on AJPS of healthy shoulders (n=79) (low certainty). Elastic KT improves AJPS (subacromial pain syndrome and rotator cuff tendinopathy, n=52) and PJPS (chronic hemiparetic shoulders, n=13) among pathological shoulders (very low certainty). Elastic KT has no effect on kinesthesia among individuals with subacromial pain syndrome (n=30) (very low certainty).

* Corresponding author at: Campus UZ Ghent, Corneel Heymanslaan 10, B3, ingang 46, 9000 Ghent, Belgium.
*E-mail:* Amanda.Ager@UGent.be (A.L. Ager).

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*Conclusion:* There is very low to low certainty of evidence that elastic KT enhances shoulder AJPS and PJPS. The aggregate of evidence is currently so low that any recommendation on the effectiveness of elastic KT on shoulder proprioception remains speculative.


## Introduction

The importance of shoulder pain within orthopaedic medicine and rehabilitation has been well established, with an estimated 30-50% of adults experiencing at least one episode of shoulder pain annually.[1] While being a meaningful reason to seek medical care, shoulder pain continues to affect a person's ability to work and their capacity to participate in activities of daily living;[2] while being a costly problem to the individual and society.[3,4] In search of more effective treatments, elastic kinesiology taping (KT) has often been used in clinical practice[5] as an additional therapeutic resource for treating shoulder pain. Kinesiology or elastic taping, also referred to as neuro-proprioceptive taping,[6] is a popular clinical tool theorized to improve proprioception.[5,7-11] It is described as being therapeutic[7] with a wide range of theoretical benefits, including (i) mimicking the elasticity of skeletal muscle[12,13] while allowing unrestricted range of motion (ROM);[12,13] (ii) improving sensory mechanisms,[12] correcting muscle function,[5] and facilitating motor activity;[8] (iii) the promotion of a neutral postural alignment and joint stability[8] and; (iv) decreased pain through neurological suppression.[5,7,8] Despite the widespread application of elastic KT in clinical practice,[14,15] its scientific effectiveness remains unclear,[16,17] particularly as it applies to shoulder proprioception.

Proprioception, or our limb's sensory awareness,[18] provides essential guidance to the shoulder through feedback regarding positioning in space (joint position sense, JPS), movement (kinesthesia), sense of force (SoF) (or sense of effort),[19] and sense of joint velocity (SoV).[20] Collectively, proprioception is essential to shoulder neuromuscular control throughout movements of the inherently unstable glenohumeral (GH) joint,[21] while also playing a crucial role in our daily lives by guiding our interactions with the world around us.[22] It is also well established that proprioception contributes to sports performance and complex tasks of daily living.[23] Therefore, improving shoulder proprioception is an important clinical goal following an injury.

The use of elastic KT in rehabilitation is thought to improve neuromuscular control,[5,24] enhance postural alignment by aiding in repositioning the humeral head within the glenoid fossa, increasing the subacromial space,[5] and also correcting scapular positioning.[25] The application of elastic KT to the skin is suggested to improve proprioception via the stimulation of local cutaneous mechanoreceptors and proprioceptors within surrounding tissues,[7,10] collecting mechanical information on tissue deformation (stretch, tension, vibration, movement, and positioning).[18]

Previous systematic reviews have been published regarding the use of elastic KT to manage musculoskeletal injuries;[26] more specifically low back pain,[27] patellofemoral pain syndrome,[28] ankle instabilities,[29] rotator cuff tendinopathies,[30] as well as among overhead athletes.[31] However, most reviews did not address the effects of elastic KT specifically on proprioception. Recently, Turgut et al.[31] evaluated the effects of all types of taping (rigid tape, elastic taping, or a combination thereof) on shoulder proprioception of overhead athletes. The authors reported minor improvements to shoulder proprioception and suggested mixed results and insufficient evidence for the effects of elastic KT on shoulder proprioception. Their results pinpoint a strong need for a review of the literature addressing the specific effects of elastic KT on shoulder proprioception. Indeed, despite the wide application of elastic KT, there is insufficient evidence to suggest that it directly affects proprioception,[27,28,30-32] except among individuals affected by ankle instabilities.[29] To our knowledge, a critical literature review has yet to address the effects of elastic KT on shoulder proprioception. Therefore, this study aims to review and synthesize the evidence of the impact of elastic KT on shoulder proprioception in healthy and pathological shoulders.

## Methods

### Identification and selection of trials

Four databases (PubMed, Web of Science, CINAHL, and SPORTDiscus) were systematically searched from their inception until December 1st 2021, to identify articles that investigated the effects of elastic KT, primarily or secondarily, in both healthy and pathological populations on shoulder proprioception; including JPS, kinesthesia, SoF, and SoV. A search strategy using PICOS (Population, Intervention, Comparison, Outcome, Study design) approach, was performed without date, geographical location, gender, sex, or language restrictions. The search was tailored for each database using their specific building block, truncation, Boolean operators, and nesting features for combining medical subject heading (MeSH) and free-text words. Details from the search strategy are available in the Supplementary Material – Table S1.

The selection of the articles followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.[33] The search yield was exported to EndNote, and, after removing duplicates, titles and abstracts of the pre-selected studies were screened by three independent reviewers (M.D., M.H., A.D.). For a double-blinded process, potentially eligible studies were randomly assigned to a pair of reviewers of a three-member blinded team working in three pairs (M.D./A.D., M.D./M.H., A.D./M.H.).

#### Eligibility criteria

To be selected for full-text screening, the article had to be a (i) RCT or a non-RCT studies of intervention investigating the effectiveness of elastic KT at the shoulder amongst healthy

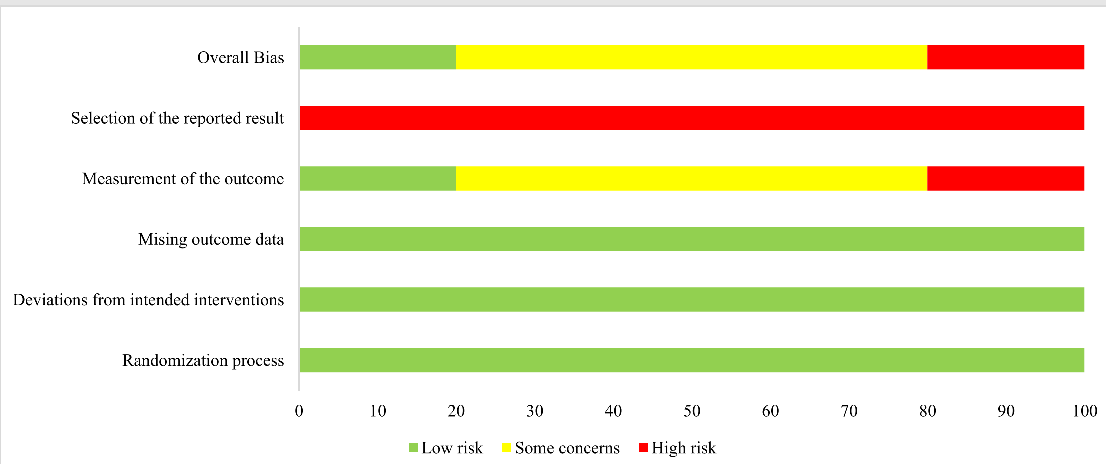
**Table 1** Risk of bias of randomized studies according to the Cochrane Risk of Bias Assessment (Version 2).[34,35]

| Study ID | Experimental | Comparator | Outcome | D1 | D2 | D3 | D4 | D5 | Overall |
|---|---|---|---|---|---|---|---|---|---|
| Shih et al. 2018 | Kinesiotaping | Placebo | AJPS | + | + | + | ! | - | ! |
| Burfeind & Chimera 2015 | Kinesiotaping | No tape | AJPS | + | + | + | ! | - | ! |
| dos Santos et al. 2017 | Kinesiotaping | Sham taping | PJPS | + | + | + | + | - | + |
| Aaserth et al. 2015 | Kinesiotaping | No tape | AJPS | + | + | + | - | - | - |
| Zanca et al. 2015 | Kinesiotaping with tension | i) No taping ii) KT without tension | AJPS | + | + | + | ! | - | ! |

+ Low risk; ! Some concerns; - High risk

**D1** = Randomisation process, **D2** = Deviations from the intended interventions, **D3** = Missing outcome data,

**D4** = Measurement of the outcome, **D5** = Selection of the reported result




**D1** = Randomisation process, **D2** = Deviations from the intended interventions, **D3** = Missing outcome data, **D4** = Measurement of the outcome, **D5** = Selection of the reported result

adult (18 and 65 years old) or symptomatic individuals with any painful shoulder condition; (ii) report at least one shoulder proprioception outcome measure (JPS/kinesthesia/SoF/SoV); and (iii) be published in English, French, or Dutch. The same three pairs of reviewers scrutinized the full-text to determine their inclusion in this review, resulting in two independent reviewers per citation. Screening results were openly discussed until a unanimous consensus was reached. Manual searching on the reference lists was conducted to find additional articles not found in the previous bibliographical searches.

## Assessment of characteristics of trials

### Risk of bias

The risk of bias (RoB) of the included studies was assessed using two assessment tools: the Cochrane Collaboration Risk of Bias tool (ROB 2) for RCTs (Table 1),[34,35] and the Risk of Bias in Non-randomized Studies - of Interventions (ROBINS-I) for non-RCTs (Table 2). Details for both tools, are available in the Supplementary Material - Table S2.

The quality of the non-RCTs assessed with ROBINS-I tools was quantified based on the overall scores. As the summary scores for quantifying the quality of the studies assessed with the ROBINS-I checklist are not yet associated with qualitative categories, the following index, suggested by de Oliveira et al.,[36] was used. A study was deemed "high quality" (HQ) for scores greater than 80.0%, "good quality" (GQ) for scores between 70% and 80.0%, "moderate quality" (MQ) for scores between 50.0% and 69.9%, and "low quality" (LQ) for scores less than 50.0%.[36] This quality assessment index allowed us to evaluate the quality of the included studies categorically, based on proprioception outcome measures.

### Certainty of evidence for proprioception outcomes

Two independent reviewers (A.L.A., F.O.) evaluated the included studies according to the grading of recommendations assessment, development and evaluation (GRADE) framework,[37-39] to establish the certainty of evidence regarding the effectiveness of elastic KT on shoulder proprioception outcomes among healthy and pathological shoulders. The evaluation of the evidence took into consideration five key domains: i) study design limitations; ii) results inconsistency; iii) indirectness of evidence; iv) imprecision, and v) publication bias.

The body of evidence for an outcome may be determined to have serious (downgraded one point), very serious (downgraded two points), or critically serious (downgraded three points, for RoB when ROBINS-I was used) issues for each domain (Supplementary material - Table S3). The GRADE quality of evidence was based on the following:

- **High quality:** Further research is very unlikely to change our confidence in the estimate of effect. Consistent findings among 75% of pooled participants in RCTs and non-RCTs of intervention with low RoB are generalizable to the population in question. Sufficient data, with narrow

**Table 2** Methodological quality for non-randomized controlled trials studies of intervention assessed with ROBINS-I Tool (2016).

| items | sub-items | Studies | | |
|---|---|---|---|---|
| | | **Lin et al. 2011**[9] | **Keenan et al. 2017**[8] | **de Oliveira et al. 2019**[5] |
| 1. Bias due to confounding | 1.1 | PY | PY | PY |
| | 1.2 | N | / | N |
| | 1.3 | / | / | / |
| | 1.4 | Y | PN | Y |
| | 1.5 | / | / | / |
| | 1.6 | N | PY | NI |
| | 1.7 | PY | PY | NI |
| | 1.8 | PY | PY | / |
| | **risk of bias judgement (item 1)** | **low** | **moderate** | **low** |
| 2. Bias in selection of participants into the study | 2.1 | N | N | N |
| | 2.2 | / | / | / |
| | 2.3 | / | / | / |
| | 2.4 | Y | PY | NI |
| | 2.5 | PY | / | / |
| | **risk of bias judgement (item 2)** | **low/moderate** | **low/moderate** | **low** |
| 3. Bias in classification of interventions | 3.1 | Y | Y | Y |
| | 3.2 | Y | Y | Y |
| | 3.3 | PN | Y | NI |
| | **risk of bias judgement (item 3)** | **low** | **low** | **low** |
| 4. Bias due to deviations from intended interventions | 4.1 | N | / | / |
| | 4.2 | N | / | / |
| | 4.3 | NI | NI | NI |
| | 4.4 | Y | Y | Y |
| | 4.5 | Y | Y | Y |
| | 4.6 | / | / | / |
| | **risk of bias judgement (item 4)** | **low** | **low** | **low** |
| 5. Bias due to missing data | 5.1 | Y | Y | Y |
| | 5.2 | N | N | N |
| | 5.3 | N | Y | N |
| | 5.4 | / | PY | / |
| | 5.5 | / | PN | / |
| | **risk of bias judgement (item 5)** | **low** | **moderate** | **low** |
| 6. Bias in measurement of outcomes | 6.1 | PY | PY | PN |
| | 6.2 | Y | Y | Y |
| | 6.3 | Y | Y | Y |
| | 6.4 | PN | PN | PN |
| | **risk of bias judgement (item 6)** | **moderate** | **moderate** | **low/moderate** |
| 7. Bias in the selection of the reported result | 7.1 | NI | NI | NI |
| | 7.2 | NI | NI | NI |
| | 7.3 | NI | NI | NI |
| | **risk of bias judgement (item 7)** | **No information** | **no information** | **no information** |
| Overall risk of bias<br>Methodological quality | | moderate risk<br>moderate quality (MQ) | moderate risk<br>moderate quality (MQ) | low risk<br>good quality (GQ) |

A description of the risk of bias is available in the Supplementary Material.
ROBINS-I scores were converted to a specific quality classification based on the classification suggested by de Oliveira et al.[36]

- low risk = good quality (GQ)
- moderate risk = moderate quality (MQ)
- serious risk = low quality (LQ)
- critical risk = very low quality (VLQ)

High quality does not exist in this categorization since the studies are non-randomized controlled trials.

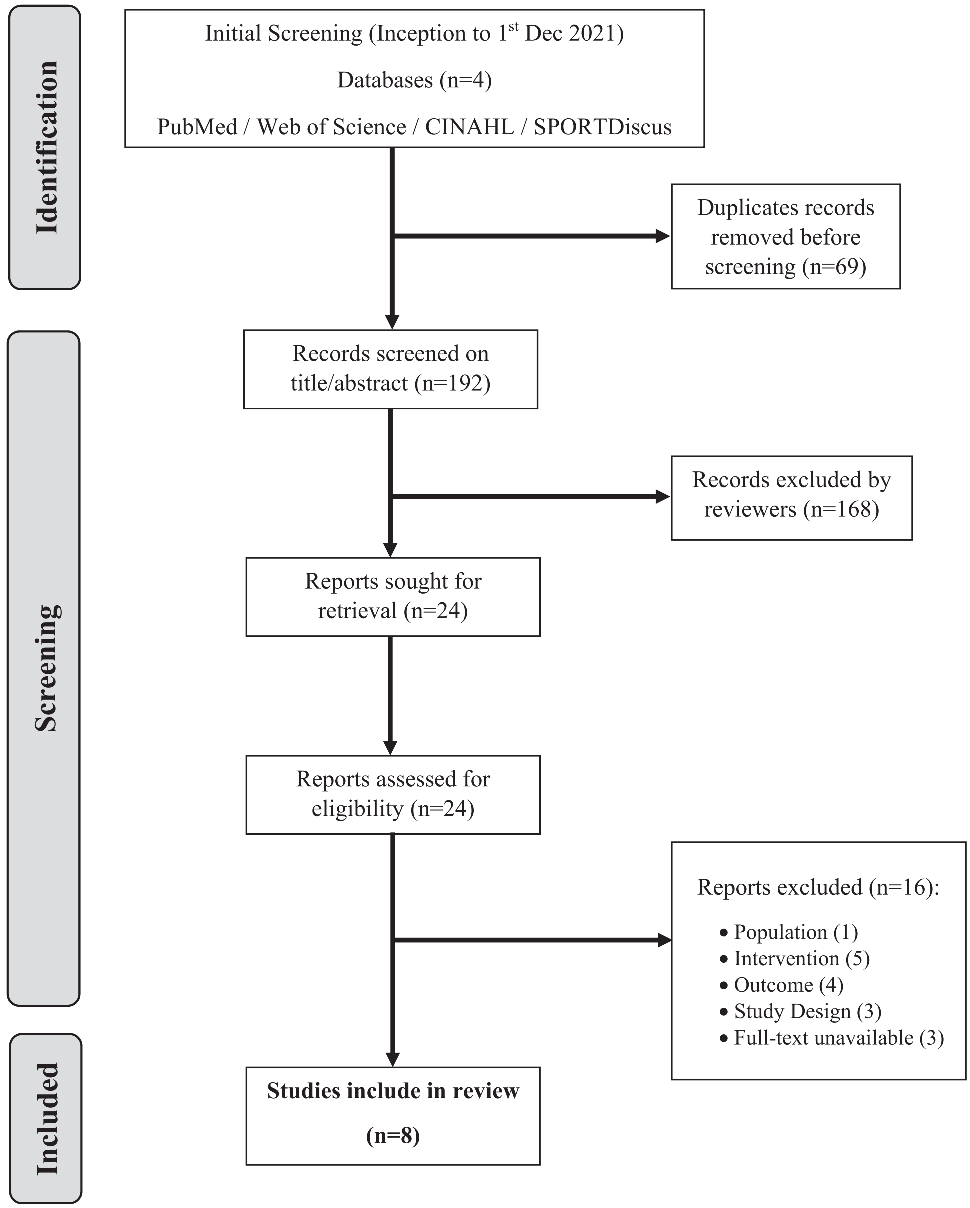



**Fig. 1** Flowchart of the literature selection process performed according to the PRISMA statement.

confidence intervals, are available. No reporting biases are known or suspected (all domains are met).

- **Moderate quality**: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate (one domain is not met).
- **Low quality:** Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate (two domains are not met).
- **Very low quality:** We are very uncertain about the estimate (three domains are not met).
- **No evidence**: We identified no RCT or non-RCT of intervention that measured the outcome.

### Data extraction

The following data from the included studies were systematically extracted by a three-member blinded team working in three pairs (M.D./A.D., M.D./M.H., A.D./M.H.): author and year of publishing, study design, sample/population, intervention/taping (type, application, technique used) and the control group, proprioception outcome measures, and overall results (see the Supplementary Material – Table S4).

### Data analysis

Because of the heterogeneity of the studies included in this review (e.g., differing populations, shoulder taping protocols, and proprioception outcome measures), the data could not be pooled into a meta-analysis. Therefore, only qualitative analyses were performed.

## Results

### Flow of trials through the review

The literature search yielded 261 citations. After removing 69 duplicates, 192 remaining citations were screened, and eight studies were included in this review (Fig. 1). Of the eight studies,[5,8,11,12,40-42] five were RCTs,[11,12,40-42] and three were non-RCTs studies of intervention.[5,8,9]

## Participants

A total of 174 participants (88 men, 86 women), including 187 shoulders (102 healthy[9,11,40,41] and 85 pathological shoulders[5,8,41,42]) were included. The mean (SD) age of the participants was 27.9 (3.9) years, and 49.4% were male. The diagnosis of the pathological shoulders included subacromial pain syndrome (SAPS, n=50)[8,42] (including overhead athletes with SAPS [n=30])[42] and rotator cuff tendinopathy (n=22),[5] and chronic hemiparesis following a stroke (n=13).[41] All included studies evaluated the dominant shoulder only,[8,11,12,40,42] except de Oliveira et al.[5] and dos Santos et al.,[41] who evaluated both the healthy and pathological shoulders. It is unclear which shoulder (dominant or non-dominant) was evaluated by Lin et al.[9]

## Proprioception subcategories

The most studied proprioception outcome measure included active joint position sense (AJPS) (6 studies, n=131)[5,9,11,12,40,42] while one study evaluated passive joint position sense (PJPS) (1 study, n=13).[41] The proprioception error (PE) was understood to be the reproduction error in degrees between the target angle and the performed angle.[5,9,11,12,40-42] One study[8] (n=30) investigated the sense of movement (kinesthesia) through a time to detection of passive motion (TTDPM) protocol. The PE was recorded as the difference between the start and stop angles and was captured as the mean absolute average error in degrees. No studies evaluating the SoF or SoV were identified.

## Equipment

Isokinetic dynamometer (Biodex Systems) (2 studies, n=43)[8,41] and FASTRAK 3-Space magnetic tracking system (2 studies, n=39),[9,12] were the most used equipment to quantify the angle differential (PE) during active or passive movements. The bubble inclinometer (n=16),[40] the Apple iPod touch with an internal accelerometer and gyroscope (n=24),[11] wireless inertial measurement unit (IMU) system (n=22),[5] and a custom-built scale ruler with a pole mounted on a 4-wheeled arm support device (n=30) were used in a single study.[42]

## Direction of movement

Both glenohumeral (GH) joint (n=144)[5,8,9,11,40,41] and scapular movements (n=30)[42] were evaluated. GH joint movements included flexion (3 studies, n=51),[5,40,41] extension (1 study, n=16),[40] internal rotation at 90° of abduction (ABD) (2 studies, n=46),[8,40] external rotation at 90° of ABD (2 studies, n=46),[8,40] ABD in the frontal plane (2 studies, n=35),[5,41] and scapular abduction (scapular plane elevation) (3 studies, n=63).[9,11,12] Scapular movements included scapular elevation (n=30), protraction (n=30), anterior/posterior tilting (n=30), and upward/downward rotation (n=30).[42]

## Taping protocols

Three studies (n=38)[8,41,42] used placebo tape (non-elastic tape), including Cover-Roll™ (n=10),[8] Cramer tape™ (n=13),[41] and 3M Micropore tape™ (n=15).[42] A single study[11] (n=24) used elastic KT as their sham taping without applying any tension. In five studies (n=98),[5,9,11,12,41] participants acted as their own controls, having both the control and intervention conditions applied to the ipsilateral shoulder. Zanca et al.[11] (n=24) explored three conditions: (i) no tape, (ii) elastic KT with tension, and (iii) elastic KT without tension applied a week apart. Lastly, three studies (n=76)[8,40,42] compared an intervention group to a control group to test the effects of elastic KT on shoulder proprioception.

## Risk of bias

The RoB of the included studies ranged from low to high, with a high level of agreement between raters for the scoring of RCTs (ICC=0.81 [0.74, 0.92]) and non-RCTs (ICC=0.94 [0.90, 0.98]). Of the included RCTs, one was deemed to have a high risk of bias,[12] three were assessed to have some concerns,[11,40,42] and a single study[41] supported a low risk of bias (Table 1). Regarding the non-RCTs (Table 2), two studies were found to have moderate risk of bias,[8,9] while the other was deemed to have low risk.[5]

## GRADE framework evidence profile and synthesis of results

Table 3 presents the analysed certainty of evidence by regrouping the studies according to the shoulder health conditions (healthy or pathological) and the proprioception outcomes (AJPS, PJPS, or kinesthesia). Currently, there is low certainty of evidence suggesting that elastic KT has mixed results on AJPS among healthy shoulders (4 studies, n=79).[9,11,12,40] Two studies[11,12] evaluating AJPS with elastic KT suggested no change to proprioception, whereas two studies[9,40] suggested a decrease in proprioception error with elastic KT; resulting in overall conflicting and low evidence with the AJPS outcomes.

In addition, there is very low certainty regarding the effects of elastic KT on AJPS in pathological shoulders (2 studies, n=52).[5,42] Very low certainty suggests that active scapular repositioning improved among pathological shoulders (1 study, n=30)[42] and no change was found with AJPS with GH joint movements (1 study, n=22).[5]

There is very low certainty for the improvement of PJPS among chronic hemiparetic (post-stroke) shoulders (1 study, n=13)[41] and also very low certainty that elastic KT has no effect on shoulder kinesthesia among individuals with SAPS (1 study, n=30)[8] (Table 4). No studies that examined PJPS or kinesthesia with elastic KT on healthy shoulders were identified for this review. As the certainty of evidence is very low or low concerning the effects of elastic KT in both healthy and pathological shoulders, regardless of the proprioception outcome evaluated, no concrete recommendations can be made at this time.

**Table 3** Summary of certainty of evidence of the included studies assessed following the GRADE guidelines.

| GRADE evidence profile | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Proprioception outcomes & Population** | **Studies** | Limitations in study design (risk of bias) | **Inconsistency** | **Indirectness (generalizability) (PICO)** | **Imprecision (sparce data; group size)** | **Publication bias** | **GRADE certainty of evidence** |
| **Active Joint Position Sense (AJPS)** | | | | | | | |
| **Healthy shoulders (n=79)** | **4 studies** | **Serious** | **Serious** | **Serious** | **Very Serious** | **Not serious** | **Low** ⊕⊕○○ |
| Conflicting results for the effects of elastic KT on shoulder proprioception | Aarseth et al. 2015 | RCT (cross-over) | | | | | |
| | Burfeind & Chimera 2015 | RCT | | | | | |
| | Lin et al. 2011 | cross-sectional non-RCT study of intervention | | | | | |
| | Zanca et al. 2015 | RCT (cross-over) | | | | | |
| **Pathological shoulders (n=52)** | **2 studies** | **Serious** | **Serious** | **Serious** | **Very serious** | **Serious** | **Very low** ⊕○○○ |
| Subacromial pain syndrome<br>Rotator cuff tendinopathy | Shih et al. 2018 | RCT cross-sectional | | | | | |
| Scapular proprioception was improved, but no reported change for GHJ proprioception | de Oliveira et al. 2019 | non-RCT study of intervention | | | | | |
| **Passive Joint Position Sense (PJPS)** | | | | | | | |
| No studies were identified as having evaluated PJPS amongst healthy shoulders. | | | | | | | |
| **Pathological shoulders (n=13)**<br>Chronic hemiparetic (post-stroke)<br>Improvement in PJPS | dos Santos et al. | **Not serious**<br>RCT cross-over | **Serious** | **Not serious** | **Very serious** | **Very serious** | **Very low** ⊕○○○ |
| **Kinesthesia (sense of movement)** | | | | | | | |
| No studies were identified as having evaluated the sense of kinesthesia amongst healthy shoulders. | | | | | | | |
| **Pathological shoulders (n=30)**<br>Subacromial pain syndrome<br>No effect. | Keenan et al. | **Serious**<br>cross-sectional Non-RCT study of intervention | **Not serious** | **Not serious** | **Very serious** | **Extremely serious** | **Very low** ⊕○○○ |

The certainty of evidence was assessed using the grading of recommendations assessment, development and evaluation (GRADE) framework.
**(Not serious)** = Quality not downgraded, **(Serious)** = Factor downgraded by one level, **(Very serious)** = Factor downgraded by two levels, **(Extremely serious)** = For non-randomized studies assessed with ROBINS-I, rating down by three levels.
**Abbreviations:** AJPS, active joint position sense; CRoB-2, Cochrane Risk of Bias Assessment (Version 2); CI, confidence interval; GHJ, glenohumeral joint, KT, kinesiology tape; PJPS, passive joint position sense; RoB, risk of bias.
The body of evidence for an outcome may be determined to have serious or very serious issues for the affected domain (or critically serious for risk of bias when ROBINS-I is used).
See the Supplementary Material for the process followed for the development and presentation of the GRADE evidence profile.

## Discussion

This systematic review is the first to our knowledge to evaluate the effectiveness of elastic KT on shoulder proprioception; more specifically, AJPS, PJPS, and kinesthesia among healthy and pathological shoulders. From our review, we present conflicting and inconsistent effectiveness of elastic KT on AJPS (low certainty) and PJPS with both healthy and pathological shoulders (very low certainty) as well as very low certainty of evidence to suggest that elastic KT influences kinesthesia among individuals with subacromial pain syndrome. Accordingly, we cannot encourage using elastic KT in clinical practice to improve shoulder proprioception. Our results echo those of past reviews involving the lower extremities and spine,[26-28] which report little to no effect of elastic KT on proprioception, except for a review addressing individuals with ankle instabilities that suggested improvements in balance, muscle strength, and proprioception.[29]

The interest in this topic arose from the common claim and belief that elastic KT can enhance proprioception; hence the clinical term "proprioceptive tape".[6,10] Elastic KT is a popular therapeutic resource used by clinicians as the material is portable, economical, requires relatively little technical training, and it is suggested to be a supportive home therapy.[13] In addition, arguments exist for a positive placebo effect with the application of elastic KT[43,44] through the positive expectancy theory,[45] suggesting that placebo-prone personalities benefit from such outcomes in the presence of positive beliefs.[47] Despite substantial claims from the manufacturers and promoters[13,46] on the effectiveness of elastic KT tape as a therapeutic modality, there is little to no evidence to corroborate the immediate or mid-term effect of elastic KT on proprioception.

Our very limited results can be partially explained by considering the hypothesized neurophysiological effects of elastic KT.[13,46] It has been argued that the main benefits of elastic KT are derived from the direct lifting of the skin,[24] which increases the space between the skin and subcutaneous tissues, promoting localized lymphatic drainage and increased blood flow.[13] Subsequently, pressure on pain receptors is relieved, reinforcing the body's self-healing capacities.[13] It is further hypothesized that the "pump action" from the lymphatic and circulatory system stimulates the localized cutaneous mechanoreceptors,[13] generating tactile and sensorimotor changes,[47] including a heightened sensation of proprioception. This theory remains questionable until further examination of the specialized mechanoreceptors within the dermis and the soft tissue surrounding a joint. However, we acknowledge that evaluating the effects of elastic KT underneath the skin is illogical if elastic KT does not show any positive clinical responses.

To understand the results of our review, it is important to consider the current understanding of proprioception feedback, arising from both joint mechanoreceptors (providing information regarding internal mechanical forces, muscle length, joint velocity, stiffness, deep pressure, acceleration/deceleration, tensile strain, joint motion, and joint position sense)[48,49] and cutaneous mechanoreceptors (providing information derived from external stimuli [discriminatory touch, pressure, skin movement – slip or flutter, skin stretching, vibration, and textures]).[47] We believe that if proprioceptive input came solely from cutaneous mechanoreceptors, our review could have found positive proprioceptive gains with PJPS and kinesthesia outcomes, as it can be theorized that a passive task does not primarily involve active mechanical tissue deformation surrounding a joint. This was not the case because the only study that investigated the effects of elastic KT on kinesthesia reported no change.[8] On the other hand, if our proprioception came solely from articular mechanoreceptors, we could anticipate no change in shoulder proprioception during AJPS tasks, as it can be argued that no direct stimulation to the deep joint mechanoreceptors occurs with the topical application of elastic KT. Our review presents inconsistent results, as some studies suggest positive effects,[9,40-42] while others have reported no effect[5,8,12,41] or a worsening[11,12] during an active joint matching task, regardless of shoulder health conditions (healthy or pathological), body segment, or joint taped. Our results raise questions whether cutaneous mechanoreceptors can be topically and superficially stimulated, as questioned by previous neurophysiological studies.[50,51] How sensory information is weighed and consolidated from cutaneous and articular mechanoreceptors within the nervous system is also of interest, as it would help researchers and clinicians further understand proprioceptive inputs as they pertain to injuries and athletic performance.

### Lack of standardisation

A significant part of our inconsistent and conflicting results, resulting in very low to low certainty of evidence, can also be explained by the lack of standardisation between studies, including the various proprioception outcome measures, the populations, taping protocols, and what part of the shoulder complex is taped. Indeed, three distinct sub-modalities of proprioception were considered (AJPS, PJPS, kinesthesia), and each elastic KT protocol used was unique (see the Supplementary Material – Table S5). Taping protocols have differed regarding anatomical location, type of elastic KT, tension applied throughout the tape, and whether the effects were intended to facilitate or inhibit the underlying musculature. Only two studies[5,41] provided enough detail about their protocols, which allow comprehension of the purpose of the taping and encourage the replication of their studies, which would permit further testing of their results. More clearly defined taping protocols that can be accurately replicated by different researchers, in addition to psychometrically tested shoulder proprioception outcome measures, are needed to move forward.

### Strengths and limitations

Strengths of this review include the meticulous search of the literature through four scientific databases, using three languages, and the application of validated risk of bias tools for critical appraisal and the development of an evidence profile using the GRADE framework. We also searched for studies evaluating all sub-modalities of shoulder proprioception, although only protocols evaluating JPS and kinesthesia were identified. Moreover, our results are systematically reported to encourage using the presented protocols and outcomes for future research on this topic.

**Table 4** Summary of findings of the effectiveness of elastic kinesiology taping on proprioception.

| Study | Main Findings | Proprioception Outcome | Study Design | Risk of Bias | GRADE certainty of evidence |
|---|---|---|---|---|---|
| **Healthy shoulders** | | | | | |
| **Aarseth et al. (2015) (n=27)** | No change at 50° or 110° of scapular abduction. ↑ proprioceptive error at 90° of scapular abduction (2.65°, *p*=0.01). | AJPS | RCT (cross-over) | High risk | **Low** ⊕⊕○○ |
| **Burfeind & Chimera (2015) (n=16)** | ↓ proprioception error in flexion (*p*=0.04) and ER (*p*=0.03). Control group (no tape): ↑ variability with their proprioception performance. | AJPS | RCT | Some concerns | |
| **Lin et al. (2011) (n=12)** | ↓ proprioception error (11.9° ± 8.3°, *p*<0.005). | AJPS | RCT (cross-sectional) | Moderate risk | |
| **Zanca et al. (2015) (n=24)** | No effects on proprioception following a muscle fatigue protocol at any angle (50°, 70°, 90° scapular abduction) (*p*=0.41). | AJPS | Randomized crossover single-blind study | Some concerns | |
| **Pathological shoulders** | | | | | |
| **Shih et al. (2018) (n=30)** | *Subacromial pain syndrome (Overhead athletes)* ↓ proprioceptive error of the scapular for up/down rotation (*p*=0.04) and anterior/posterior tilting (*p*=0.03) | AJPS | RCT | Some concerns | **Very low** ⊕○○○ |
| **de Oliveira et al. (2019) (n=22)** | *Rotator cuff tendinopathy* No reported change to proprioception with elastic KT at low or mid-amplitudes (45°-65°, 80°-100°) (*p*>0.05). | AJPS | Cross-sectional | Low risk | |
| **Dos Santos et al. (2017) (n=13)** | *Chronic hemiparetic (post-stroke)* ↓ PJPS error in abduction at 30° and 60° as well as flexion at 30° and 60° (all *p*<0.010). Proprioception improved regardless of the level of sensorimotor impairment. | PJPS | Randomized sham-controlled cross-over study | Low risk | **Very low** ⊕○○○ |
| **Keenan et al. (2017) (n=30)** | *Subacromial pain syndrome* Elastic KT did not have an effect on kinesthesia (0.033≤ *p* ≤0.77). | Kinesthesia | Placebo controlled quasi-experiment | Moderate risk | **Very low** ⊕○○○ |

Abbreviations: AJPS, active joint position sense; ↑, increase; ↓, decrease; KT, kinesiology tape; PJPS, passive joint position sense.
Methodological quality assessed with Risk of bias of randomized studies according to the Cochrane Risk of Bias Assessment (Version 2) and ROBINS-I (non-RCTs of intervention).
Level of evidence assessed with GRADE framework.
The GRADE certainty of evidence can be evaluated as very low, low, moderate or high certainty (See the Supplementary Material).
As the evidence has been evaluated to be of very low to low quality, and only a small number of studies have been identified which evaluated a shoulder proprioception outcome, a strength of recommendation could not be determined. The aggregate of evidence is currently so low that any recommendation on the effectiveness of elastic KT on shoulder proprioception outcomes remains speculative.

Despite the methodological rigour, we recognise several limitations of this systematic review. First, weak reporting of psychometric properties, effect sizes, and small sample sizes limits the robustness of our conclusions. The certainty of evidence profile seems to have been impacted by the few identified studies and small samples for each proprioception outcome evaluated. Consequently, no concrete recommendations can be made at this time as the evidence remains conflicting and speculative (very low to low certainty of evidence).

Second, limited shoulder pathologies evaluated within the included studies may also hinder the broader clinical applicability of our findings. Future studies with a variety of shoulder pathologies are encouraged. Third, none of the included studies evaluated the effects of elastic KT beyond a single laboratory session, which hampers establishing the mid or long-term effects of elastic KT on shoulder proprioception. Therefore, our results can only be considered in the short-term. The aggregate of these factors limits the pooling of data for a meta-analysis and, ultimately, narrows the application of our findings for clinical practice. Standardized taping protocols and proprioception outcome measures are needed to address whether elastic KT influences shoulder proprioception in the short-, mid- or long-term.

### Clinical recommendations

From our results, we have insufficient scientific evidence to recommend or discard the clinical application of elastic KT for the improvement of shoulder proprioception (very low to low certainty of evidence). Further studies investigating different shoulder elastic KT protocols and functional proprioception outcome measures are encouraged to establish the clinical effectiveness of elastic KT on known shoulder proprioception deficits across a wider variety of shoulder pathologies.[52,53]

## Conclusions

The application of elastic KT on healthy shoulders demonstrated mixed results with AJPS, where two studies indicated an improvement to proprioception and two indicated no change (low certainty of evidence). There is very low certainty that elastic KT improves AJPS among pathological shoulders (individuals with subacromial pain syndrome or rotator cuff tendinopathy) or PJPS (individuals with chronic hemiparetic shoulder). Furthermore, the use of elastic KT has no effect on kinesthesia (individuals with subacromial pain syndrome) (very low certainty). As the evidence suggests very low to low certainty regarding the effectiveness of elastic KT on the evaluated sub-modalities of shoulder proprioception, further research is necessary before elastic KT can be supported as an effective clinical rehabilitative approach.

## Conflicts of interest

The authors declare no conflict of interest.

## Supplementary materials

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.bjpt.2023.100514.

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