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Isokinetic trunk training on pain, disability, and strength in non-specific low back pain patients: A systematic review and meta-analysis

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Abstract.
BACKGROUND: Low back pain is one of the leading causes of disability globally, with a high economic and social burden. A decrease or imbalance in trunk strength has been associated with the occurrence of low back pain and its severity. Trunk strength training is helpful in the treatment of Non-specific low back pain (NSLBP) patients. However, we do not know the effects of trunk isokinetic training (IKT) on pain intensity, disability, and trunk strength.
OBJECTIVE: This systematic review aimed to determine the effects of trunk IKT in NSLBP patients on pain intensity, disability, and trunk flexor and extensor isokinetic strength.
METHODS: We searched PubMed, Web of Science, Scopus, CENTRAL, and PEDro, from January 2001 until March 2021 and updated to November 2022. Randomized controlled trials (RCTs) that investigated the effect of IKT in adult participants with NSLBP on pain intensity, disability, or isokinetic trunk strength were included. Mean difference (MD) and 95% confidence intervals (95% CI) were calculated for pain. Bias was assessed using the Cochrane risk of bias (RoB) tool and evidence certainty via Grading of Recommendations Assessment, Development and Evaluation (GRADE).
RESULTS: Among 1750 retrieved articles, eight were included in this review. Meta-analysis comparing IKT (trunk isokinetic training, $n = 134$) with control groups (conventional exercises, $n = 133$) revealed that IKT decreases pain intensity (MD -1.50 (95% CI: -2.60; -0.39)) immediately post-intervention, and one month (MD -1.97 (95% CI: -2.92; -1.03)) and at six months follow-up (MD -2.48 (95% CI: -2.77; -2.19)), although with a very low to low quality according to the GRADE rating. Besides, IKT decreases disability and increases isokinetic trunk strength, but with scant evidence.
CONCLUSIONS: Trunk IKT could be a novel clinical tool for pain management in patients with NSLBP, although evidence is scarce. In addition, few RCTs exist for IKT on disability or trunk isokinetic strength in patients with NSLBP. Therefore, further research on this topic is needed.

Keywords: Rehabilitation, exercises, strengthening, dynamometer, core muscles, chronic pain

1. Introduction

Low back pain (LBP) is one of the most common musculoskeletal condition [1,2] and is an alarming health problem that has increased worldwide [3]. Glob-

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ally, LBP is the leading global cause of years lived with disability [4]. The prevalence of LBP in 1990 was 377.5 million; however, this increased to 577 million in 2017 [4]. LBP includes pain, muscle tension, or stiffness located below the costal margin and above the lower gluteal folds, with or without sciatica [5]. It can be characterized in terms of temporality as acute LBP, less than six weeks, subacute LBP between 6 and 12 weeks, and chronic LBP, when the pain extends beyond 12 weeks [6]. Recurrence of LBP is expected; with more than two-thirds of individuals (69%) having a recurrence within 12 months after recovery. Of these, 40% will suffer functional disability or require medical care [7].

Regarding LBP, 90% of cases do not have a specific cause, so it is called non-specific LBP (NSLBP) [8]. Despite this, multiple factors have been associated with the occurrence of NSLBP [9,10], including deconditioning the lumbar musculature [11,12], reduced trunk muscle mass [13], imbalance, and decreased trunk strength [14,15]. Thus, trunk strengthening has been proposed for manage LBP patients [16–18]. Furthermore, different trunk training methods have been investigated, such as motor control exercises [19], core stabilization [20,21], and strengthening exercises using an isokinetic dynamometer [22].

The isokinetic dynamometer is the gold standard in strength assessment [23]. It has been previously used to assess trunk strength in healthy subjects and NSLBP patients [24–26]. Given its capacity to develop maximum strength, the precision with training can be programmed, and its high reproducibility, it could be considered a valuable tool for strength training [27]. In addition, it provides real-time visual and auditory feedback, which could benefit treatment adherence and allow objective monitoring of training results. The most distinctive characteristic of this device is the accommodation of the resistance provided by the dynamometer, which allows for maximal muscle loading throughout the entire range of motion [28].

Isokinetic training (IKT) helps train the shoulder musculature [29] and re-establishing rotator cuff strength ratios [30]. Furthermore, in lower limbs decrease reaction times [31] and increase strength and symmetry [32], explosive strength [33], muscle mass and strength post knee surgery [34,35]. Isokinetic trunk training has been used in different populations. For example, IKT of the trunk rotator muscles may help improve the performance of world-class canoe sprinters [36]. In addition, isokinetic trunk muscle strength training effectively improves muscle function and proprioception in patients with chronic lumbar disc herniation [37]. However, in patients with a history of low back pain, isokinetic trunk extensor training has not been shown to decrease LBP recurrences [38]. To our knowledge, there is no consensus regarding whether isokinetic trunk training has benefits in NSLBP patients. Therefore, this review aimed to determine the effects of isokinetic trunk training on pain intensity, disability, and isokinetic trunk strength in NSLBP patients.

2. Methods

2.1. Protocol and registration

The PRISMA (Preferred Reporting Items for Systematic Review and Meta-Analyses guidelines) guidelines were used [39] (Supplementary Table S1). In addition, the protocol of this review was registered in PROSPERO (International Prospective Register of Systematic Reviews) (CRD42021247030).

2.2. Search strategy

On March 30, two authors (WR-F and DJ-M) performed the search. The databases used were PubMed, Web of Science, Scopus, CENTRAL, and PEDro. The initial search was performed from January 2011 to March 30th, 2021. The following keywords were included: "*CORE strengthening*", "*trunk strengthening*", "*isokinetic exercise*", "*muscle strength*", "*dynamometer*", "*isokinetic training*", "*CORE*", "*abdominal muscles*", "*abdominal wall*", "*torso*", "*trunk*", "*low back pain*", "*low back ache*", "*back pain*" and "*lumbago*". Due to the low number of articles retrieved and to identify the largest number of potential articles for this review, a second search was performed following the same search strategy between January 2001 and December 2010. Search strategies are presented in Supplementary Table S2. Bibliographies of previous related reviews and selected studies were manually screened for new relevant studies. An update of the search was conducted until November 17, 2022.

2.3. Eligibility criteria

Articles that met the following criteria were included in this review: (1) Population: adult participants (age $\geqslant$ 18 years) with a medical diagnosis of NSLBP, i.e., low back pain without an evident pathoanatomical cause; (2) Intervention: isokinetic trunk flexors and extensors strength training; (3) Comparison: any conservative treatment or control interventions based on physical exercises or no intervention control group; (4) Outcomes: assessment of at least one of the following clinical effects: pain intensity (assessed using a visual analog scale, numerical rating scale, or any other scale), disability (assessed by questionnaire), and isokinetic trunk flexors and extensors strength (assessed by isokinetic dynamometer); (5) Studies: randomized controlled trials published in the last 20 years, without language restrictions, to identify as many articles as possible. In addition, we excluded (I) studies that only included healthy individuals or patients with specific low back pain, (II) gray literature such as conference presentations, theses, books, editorials, review articles, and expert opinions, (III) duplicate articles, and (IV) articles with missing data.

2.4. Study selection

Articles retrieved from the initial search were entered into the Rayyan QCRI application, an App that assists in the article selection process, optimizing evaluation time, and allowing collaborative work (available for free at http://rayyan.qcri.org (accessed March 30, 2021)) [40]. Duplicate references were removed. Next, two independent investigators (WR-F and DJ-M) reviewed titles and abstracts to identify articles relevant to the systematic review. Full-text reading of these articles was then performed to assess eligibility criteria, and finally, the reference list was checked for relevant articles that could be included. Disagreements were resolved by consensus. When the agreement was not achieved, a third investigator was consulted (LC-R).

2.5. Risk of bias of individual studies

The risk of bias (RoB) for each individual study was assessed with The Cochrane Collaboration Risk of Bias Tool using Review Manager 5.4 [41]. This tool evaluates the RoB according to the following six domains: random sequence generation, allocation concealment, blinding, incomplete outcome data, selective outcome reporting, and "other sources of bias." Critical assessments on the RoB are made separately for each domain, and it could be considered as "low," "high" or "unclear" RoB (if reporting was not sufficient to assess the domain) [42]. RoB assessment were independently performed by two reviewers (WR-F and DM-G). In case of discrepancy, a third evaluator (LC-R) was consulted.

2.6. Rating the quality of evidence

The quality of the evidence was rated using the Grading of Recommendation, Assessment, Development, and Evaluation (GRADE) approach [43]. GRADE offer four levels of evidence: High, moderate, low, and very low. The GRADE pro system (https://www.gradepro.org) was used for each outcome from meta-analysis to create a summary of findings (SoF) table.

2.7. Data collection process

Data extraction was performed by three independent researchers (WR-F, A-RP, and DM-G); the information extracted was related to article identification (authors, country, and year of publication), participant characteristics (sample, gender, and age), and isokinetic and other training protocols (sessions/week). In addition to variables under study, and main results. All calculations were conducted using a Microsoft Excel (Microsoft, Redmond, WA, USA) spreadsheet containing data extracted from each publication.

2.8. Synthesis methods

Review Manager (RevMan) version 5.4 was used for all the statistical analyses. The comparison was made between the IKT trunk group and the control group (conventional exercises). A p value < 0.05 was considered significant. Statistical heterogeneity was assessed using The Cochran Q statistic [44] and I^2 ($I^2 > 50\%$ was considered indicative of high heterogeneity).

The effect of the IKT interventions on pain intensity was calculated using the mean difference (MD). Means and standard deviations (SD) of the post-intervention values of both IKT and control groups were obtained from the included studies and added to RevMan 5.4. Random-effects inverse variance (IV) was used with the measurement of the effect of MD. A random-effects model was incorporated when the assumption is that the data demonstrated effects across studies that are randomly situated around a central value [45]. Forest plots were generated to illustrate the specific differences between the group's effects on pain intensity and MD within the respective 95% CIs.

3. Results

3.1. Study selection

We found no systematic reviews with an objective similar to that of the present study. From the initial search, 1750 articles were retrieved (Fig. 1), of which 517 were eliminated as duplicates. After evaluating

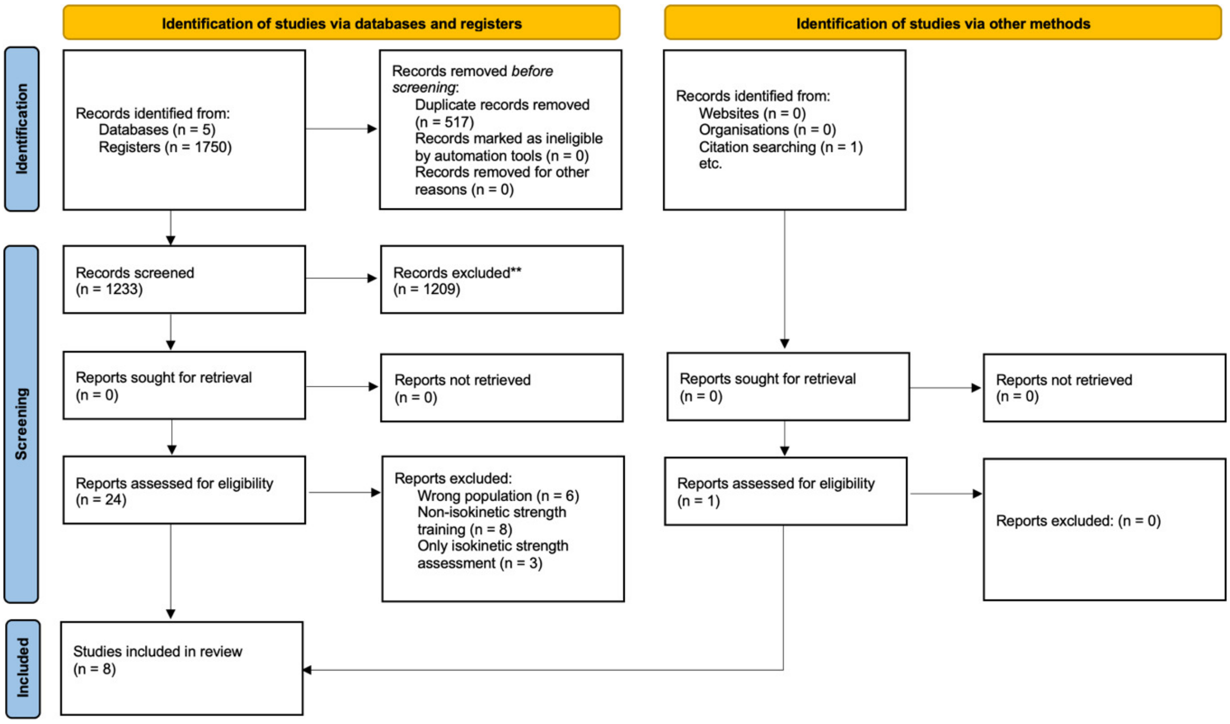

Fig. 1. Flow chart for the systematic review.

titles and abstracts, 1209 articles were excluded as not relevant to this review, leaving 24 articles for full-text reading. One additional article was identified from other sources.

From the 25 articles, six articles were excluded because they did not include patients with NSLBP, eight because they performed strength training but not isokinetic strength training, and three because they only performed isokinetic strength assessment and not isokinetic strength training. Thus, eight articles were selected, seven included in the meta-analysis. The reference list was reviewed without finding new articles. An update of the search was conducted until 17 November 2022; however, no articles met the inclusion criteria.

3.2. Study characteristics

The retrieved studies included 361 participants with NSLBP, of whom only 19.66% (71) were women. Of the total sample, 143 received IKT. The number of participants per study ranged from 17 [22] to 60 [46–49]. The minimum age of participants was 20.23 $\pm$ 1.6 [50], and the maximum was 43 $\pm$ 9.7 years [22]. Four studies [46–48,50] involved an athlete population (soccer players). All studies considered participants with chronic LBP (cLBP), i.e., at least three months (Table 1).

Regarding training protocols, all studies considered a trunk IKT group compared to a control group (CG). The CG performed conventional exercises such as stretching and isotonic and isometric exercises of the trunk muscles. In addition, Nambi et al. [47,48] included a core stability training group and Nambi et al. [46,50] a virtual reality training group. For the analysis, core stability and virtual reality training groups were not included. The total intervention period ranged from two [22] to twelve weeks [51], with total training sessions between six [22] and twenty-four [51]. Concerning the dynamometers, Nambi et al. [47,48,50] used Biodex Corporation, NY, USA, Calmels et al. [22] and de Freitas et al. [51] a Cybex 6000® Dynamometer, Sertpoyraz et al. [52] Cybex Norm Computerized Isokinetic. In contrast, Olivier et al. [49] and Nambi et al. [46] did not specify the dynamometer used (Table 2).

3.3. Risk of bias within studies

Figures 2 and 3 show the RoB assessment for all articles. For the overall RoB, only one article [52] rated 85.7% of their articles items as low RoB; four [46–48,50] ordered 57.1% of their items as low RoB,

Table 1
Characteristics of the included studies

Author	Year/country	Study design	Sample size	Gender	Age (years ± SD)	LBP classification	Outcomes	Instrument
Nambi et al. (A) [47]	2020/Saudi Arabia	RCT	60 LBP. CG: 20. IKT: 20. CST: 20.	60 Males	CG: 21.38 ± 1.4 IKT: 21.11 ± 1.4 CST: 22.12 ± 1.3	Chronic (⩾ 3 months).	**Pain intensity** Player wellness Sprint & Jump performances	**VAS** Questionnaire Sprint & jump test
Nambi et al. (B) [50]	2020/Saudi Arabia	RCT	45 LBP. CG: 15. IKT: 15. VRT: 15.	45 Males	CG: 20.78 ± 1.6; IKT: 20.23 ± 1.6; VRT: 21.25 ± 1.2.	Chronic (⩾ 3 months).	**Pain intensity** Player wellness, Sprint & Jump performances	**VAS** Questionnaire Sprint & jump test
Nambi et al. (C) [48]	2020/Saudi Arabia	RCT	60 LBP. CG: 20. IKT: 20. CST: 20.	60 Males	CG: 21.9 ± 1.8; IKT: 22.1 ± 1.8; CST: 22.3 ± 1.7.	Chronic (⩾ 3 months).	**Pain intensity** Paraspinal CSA Multifidus thickness Inflammatory biomarker	**VAS** MRI Ultrasound Blood analysis
Olivier et al. [49]	2008/France	RCT	60 LBP. CG: 30. IKT: 30.	33 Males 27 Females	39 ± 9.	Chronic (⩾ 3 months).	**Pain intensity** Isokinetic strength Quality of life Flexibility Trunk endurance	**VAS** Cybex norm Dallas score Finger to floor McGill battery
Calmels et al. [22]	2004/France	RCT	17 LBP. IKT: 9. CG: 8.	16 Males 1 Female	43 ± 9.7.	Chronic.	**Pain intensity** Disability Trunk mobility Muscle extensibility and strength	**VAS** Quebec scale Schöber index Biering Sorensen and Shirado ito test
Sertpoyraz et al. [52]	2009/Turkey	RCT	40 LBP. IKT: 20. CG: 20.	9 Males 31 Females	IKT: 38.75 ± 7.81; CT: 38.25 ± 7.36.	Chronic (⩾ 3 months).	**Pain intensity** Disability Isokinetic strength Spinal mobility Depressive symptoms	**VAS** MOLBDQ Cybex norm Finger to floor Questionnaire
Nambi et al. [46]	2021/Saudi Arabia	RCT	60 LBP. CG: 20. IKT: 20. VRT: 20.	60 Males	CG: 23.3 ± 1.5; IKT: 22.8 ± 1.6; VRT: 23.2 ± 1.5.	Chronic (⩾ 3 months).	**Pain intensity** Kinesiophobia Hormonal values	**VAS** TSK-17 Blood serum analysis
de Freitas et al. [51]	2008/Brazil	RCT	19 LBP. CG: 10 IKT: 9.	7 Males 12 Females	CG: 31.2 ± 8.2; IKT: 37.9 ± 11.2	Chronic (⩾ 3 months).	**Pain intensity** Disability Isokinetic strength Flexibility and lumbar mobility	**VAS** RMQ Cybex 6000 Schöber and Finger to floor

LBP: Low back pain; CG: control group; IKT: isokinetic training; CST: core stability training; VRT: virtual reality training; RCT: randomized controlled trial; SD: standard deviation; VAS: visual analogue scale; CSA: cross-sectional area; MRI: Magnetic resonance imaging; MOLBDQ: Modified Oswestry Low Back Disability Questionnaire; TSK-17: Tampa Scale; RMQ: Roland Morris questionnaire.

Table 2
The characteristics of isokinetic strengthening training of the included studies

Author/year	Group/intervention	Isokinetic training protocols	Dosage/velocities	Frequency (x per week)	Intervention length (week)	Dynamometer
Nambi et al. 2020(A) [47]	IKT: Isokinetic strengthening CST: Core stability exercise CG: Conventional rehabilitation.	Warm-up: five min. Flexor/extensor stretching. Position: standing ROM: 90° Familiarization (video).	Training: 15 reps × 3 sets Velocities: 60°/s, 90°/s, and 120°/s.	5	4	Biodex Corporation, NY, USA.
Nambi et al. 2020(B) [50]	IKT: Isokinetic strengthening VRT: Virtual reality training exercise CG: Conventional rehabilitation.	Warm-up: five min. Flexor/extensor stretching. Position: standing ROM: 90° Familiarization (video).	Training: 15 reps × 3 sets Velocities: 60°/s, 90°/s, and 120°/s.	5	4	Biodex Corporation, NY, USA.
Nambi et al. 2020(C) [48]	IKT: Isokinetic strengthening CST: Core stability exercise CG: Conventional rehabilitation.	Warm-up: five min. Flexor/extensor stretching. Position: standing ROM: 90° Familiarization (video).	Training: 15 reps × 3 sets Velocities: 60°/s, 90°/s, and 120°/s.	5	4	Biodex Corporation, NY, USA.
Olivier et al. 2008 [49]	IKT: Isokinetic strengthening + Conventional rehabilitation CG: Conventional rehabilitation.	Day hospitalization Three phases	*Week 1*: 8 reps × 2 sets at 120°/s; 7 reps × 2 sets at 105°/s, and 4 reps × 1 set at 90°/s. *Week 2*: 7 reps × 2 sets at 90°/s; 6 reps × 2 sets at 75°/s 5 reps × 2 sets at 60°/s, and 2 reps × 1 set at 30°/s. *Week 3 and 4*: 8 reps × 2 sets at 120°/s; 7 reps × 2 sets at 105°/s; 6 reps × 2 sets at 75°/s; 4 reps × 2 sets at 60°/s, and 2 reps × 2 sets at 30°/s.	5	4	Not reported.
Calmels et al. 2004 [22]	IKT: Isokinetic strengthening CG: Conventional rehabilitation.	Warm-up: ten min. Position: standing ROM: 70°. Familiarization only in the first session.	*Session 1 and 2*: 7 reps × 2 sets at 30°/s and 60°/s. *Session 3 to 6*: 9 reps × 2 sets at 120°/s; 7 reps × 2 sets at 105°/s; 5 reps × 2 sets at 90°/s, and 3 reps × 2 sets at 60°/s.	3	2	Cybex 6000®.
Sertpoyraz et al. 2009 [52]	IKT: Isokinetic strengthening CG: Conventional rehabilitation.	Warm-up: ten min. Position: standing ROM: 90°.	Training: 5 reps × 3 sets Velocities: 60°/s, and 90°/s.	5	3	Cybex Norm Computerized Isokinetic, Cybex Company, New York.
Nambi et al. 2021 [46]	IKT: Isokinetic strengthening VRT: Virtual reality training exercise CG: Conventional rehabilitation.	Warm-up: five min. Flexor/extensor stretching. Position: standing ROM: 90° Familiarization (video).	Training: 15 reps × 3 sets Velocities: 60°/s, 90°/s, and 120°/s.	5	4	Not reported.
de Freitas et al. [51]	IKT: Isokinetic strengthening CG: Conventional rehabilitation.	Stretching. ROM: 100° Three phases	*Month 1*: 8 reps × 10 sets. *Month 2*: 10 reps × 10 sets. *Month 3*: 12 reps × 10 sets. Velocities: 90°/s, and 120°/s.	2	12	Cybex 6000®.

IKT: isokinetic training; CST: core stability training; CG: control group; VRT: virtual reality training; ROM: range of movement; reps: repetitions.

Table 3
Summary of findings (SoF) and quality of evidence (GRADE) for Isokinetic trunk training in NSLBP patients

Certainty assessment							No. of patients		Effect absolute	Certainty	Importance
No. of studies	Study design	RoB	Inconsistency	Indirectness	Imprecision	Other considerations	IKT	CG	(95% CI)		
Pain intensity immediately post intervention											
7	RCT	Serious[a]	Very serious[b]	Not serious	Serious[c]	None	123	123	MD −1.50 95% CI (−2.60 to −0.39)	⊕○○○ Very low	Important
Pain intensity 1 month follow up											
3	RCT	Serious[a]	Very serious[d]	Not serious	Serious[c]	None	54	53	MD −1.97 95% CI (−2.92 to −1.03)	⊕○○○ Very low	Important
Pain intensity 3 months follow up											
2	RCT	Serious[a]	Very serious[b]	Not serious	Serious[c]	None	39	38	MD −1.88 95% CI (−5.29 to 1.53)	⊕○○○ Very low	Important
Pain Intensity 6 months follow up											
2	RCT	Serious[a]	Very serious[e]	Not serious	Not serious	None	35	34	MD −2.48 95% CI (−2.77 to −2.19)	⊕⊕○○ Low	Important

RoB: Risk of bias; IKT: Isokinetic training; CG: control group; CI: confidence interval; RCT: Randomized controlled trial; MD: mean difference. Explanations: a. Differences in the population assessed; b. The heterogeneity between studies was considerable (I^2=99%); c. lack of clinical relevance for VAS; d. The heterogeneity between studies was considerable (I^2 =94%); e. The heterogeneity between studies was substantial ($I^2 = 67\%$).
GRADE: Working Group grades of evidence.
High certainty: We are very confident that the true effect lies close to that of the estimate of the effect.
Moderate certainty: We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different.
Low certainty: Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect.
Very low certainty: We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect.

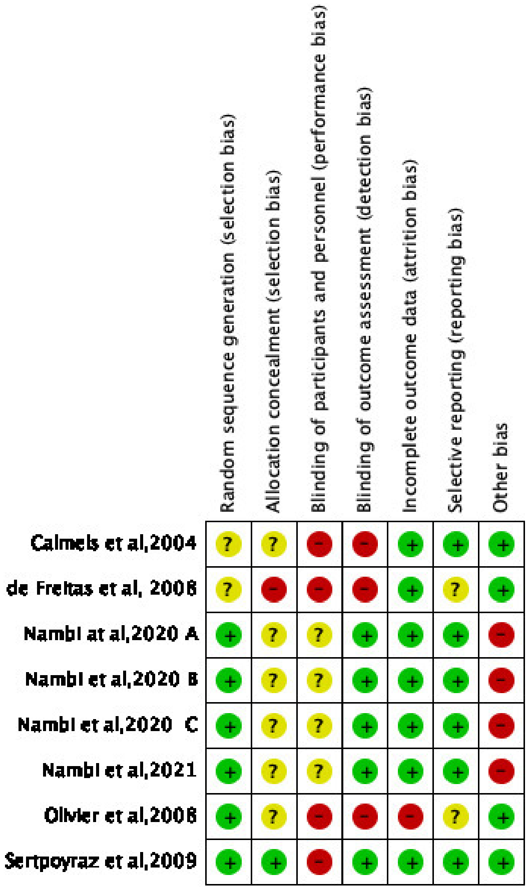

Fig. 2. Risk of bias summary: review authors' judgements about each risk of bias item for each included study.

and three [22,49,51] obtained less than 50% of the items classified as low RoB. Of the eight articles, 87.5% were classified as low RoB in the attrition bias [22,46–48,50–52], 75% were classified as low RoB in the randomization process [46–50,52], and reporting bias [22,46–48,50,52]. Only one article in allocation concealment [52], none in the blinding of participants and personnel, and 62.5% in the blinding of outcome assessment [46–48,50,52]. Four articles [46–48,50] were classified as high RoB in "other bias" due to the specific population in which they performed the intervention.

3.4. *Effect of isokinetic strengthening training*

3.4.1. *Pain intensity*

All the retrieved studies in this review evaluated pain intensity using the visual analog scale (VAS). For this reason, we performed a meta-analysis of pain intensity. One article could not be incorporated into the meta-analysis because it reported a significant decrease in pain in both groups (IKT and CG) but only indicated $p < 0.05$ [51]. In all articles, the pain intensity decreased significantly in the IKT and CG, except for Calmels et al. [22], where pain intensity decreased significantly only in the CG. The meta-analysis (Fig. 4) shows a significant decrease in pain intensity in favor of the IKT group -1.50 ((95% CI -2.60; -0.39); $n = 123$; $p < 0.008$) compared to CG. There was a very low quality of evidence, according to the GRADE rating (Table 3).

At one month follow-up, the meta-analysis revealed a significant decrease in pain intensity, in favor of the IKT group of -1.97 ((95% CI -2.92; -1.03); $n = 54$; $p < 0.0001$); at three months follow-ups of -1.88 (95% CI -5.29; 1.53; $n = 39$; $p = 0.28$) with significant heterogeneity, $I^2 = 94\%$ and $I^2 = 99\%$ respectively, and very low quality of evidence according to the GRADE rating. There was a significant reduction in pain intensity at six months follow-up in favor of the IKT group of -2.48 ((95% CI -2.77; -2.19); $n = 35$; $p < 0.00001$) and low quality of evidence according to the GRADE rating (Fig. 4 and Table 3).

3.4.2. *Disability*

Three of the articles retrieved in this review evaluated the effects of an IKT program on disability. Calmels et al. [22] used the Quebec scale to measure functional capacity and found no significant improvements in either the CG ($p = 0.606$) or the IKT group ($p = 0.233$). On the other hand, Sertpoyraz et al. [52], using the Modified Oswestry Low Back Disability Questionnaire (MOLBDQ), reported a significant decrease in disability in the CG and IKT ($p < 0.05$) at the end of the intervention and one-month follow-up. Finally, de Freitas et al. [51] reported a significant decrease in disability in the IKT ($p = 0.007$) and CG ($p = 0.005$) groups, with no differences between groups, using the Roland Morris questionnaire. Unfortunately, a meta-analysis was not performed as we could not pool the results due to the difference in disability measurement instruments and the reduced number of articles available.

3.4.3. *Isokinetic trunk flexor and extensor strength*

Only three articles of the retrieved studies evaluated the isokinetic trunk flexor and extensor strength. Olivier et al. [49] found a significant increase between pre-and post-intervention peak torque values in trunk flexor and extensor muscles. However, they only reported statistically significant differences in extensor peak torque between groups at 30°/s in favor of the IKT group. At a three-month follow-up, the two groups

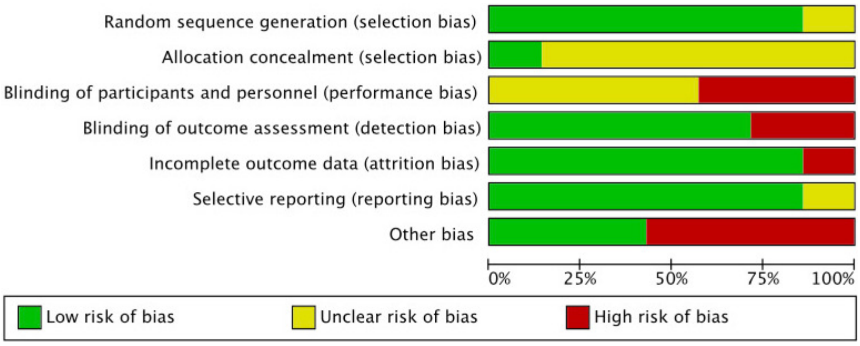

Fig. 3. Risk of bias graph: review authors' judgements about each risk of bias item presented as percentages across all included studies.

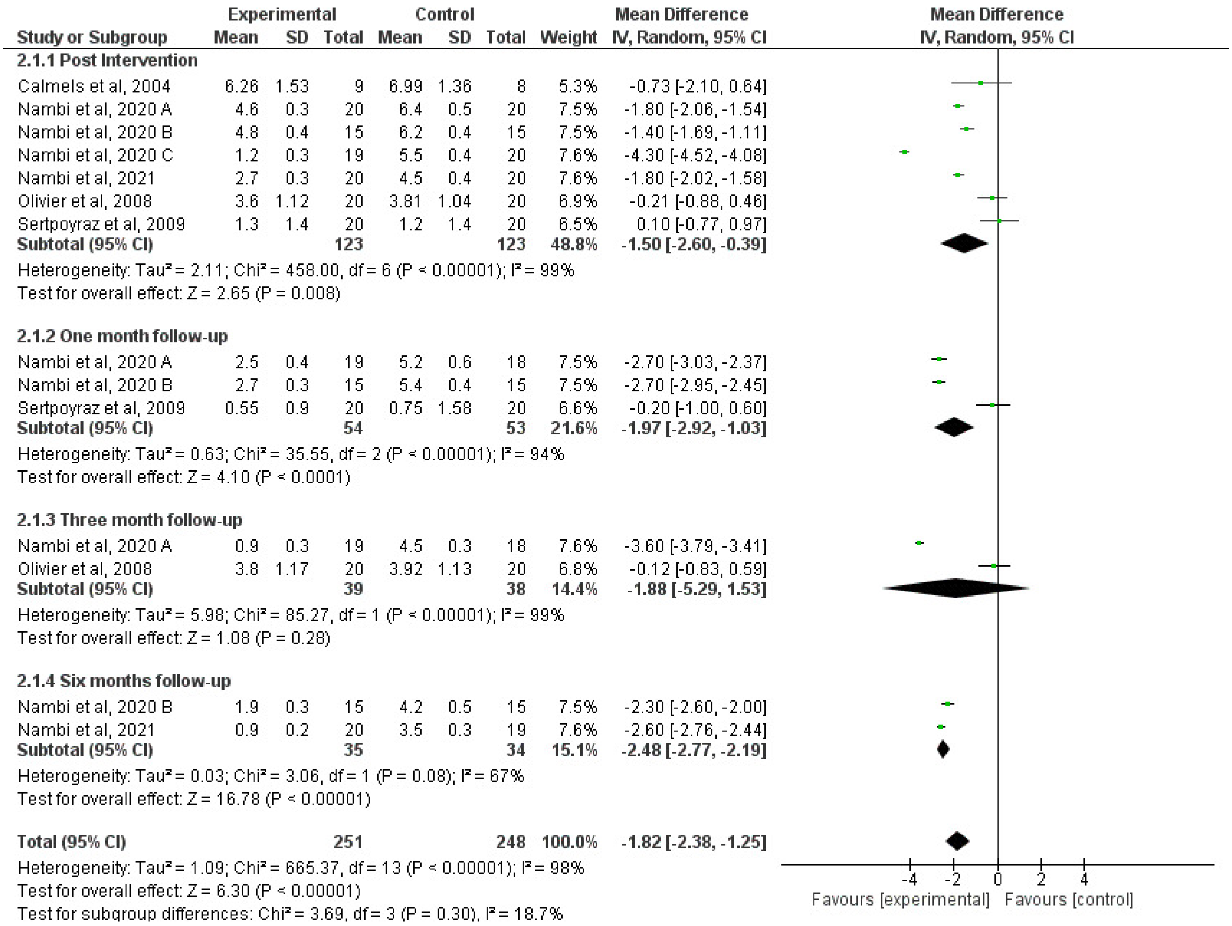

Fig. 4. Forest plot of comparison between IKT (experimental) vs CG articles for changes in pain intensity. SD = standard deviation; 95% CI = 95% confidence interval; IV = inverse variance.

improved equally. Sertpoyraz et al. [52] reported a significant increase in peak torque evaluated at 60°/s and 90°/s in both groups immediately post-treatment and at one-month follow-up ($p < 0.05$). Finally, de Freitas et al. [51] found a significant increase between pre-and post-intervention peak torque values in trunk extensor muscles at 120°/s in both groups, with no differences between groups. Unfortunately, we could not pool the data due to differences between the measurement velocities performed in each study and the reduced number of articles available.

4. Discussion

The objective of this review and meta-analysis was to determine the effects of isokinetic trunk training on pain, disability, and isokinetic trunk strength in NSLBP patients. The main finding of this review is that the trunk IKT could be a clinical tool for pain management in patients with NSLBP, although the evidence is very uncertain. In addition, IKT reduces disability and increases trunk strength in NSLBP patients, although few RCTs exist for IKT on disability or trunk strength in patients with NSLBP.

All the studies included in this review considered patients with cLBP, that is, lasting more than three months. When comparing the clinical manifestations between patients with acute, subacute, or chronic LBP, the latter presents a higher level of pain, greater consumption of analgesics, and greater risk of requiring lumbar surgery than patients with acute and subacute LBP [53]. This review and meta-analysis show decreased pain intensity in the IKT group. The IKT group presents a more significant decrease in pain intensity post-intervention (−1.50 (95% CI −2.60; −0.39)) and follow-up at one month (−1.97 (95% CI −2.92; −1.03)) and six months (−2.48 (95% CI −2.77; −2.19)) compared to CG. Thus, IKT appears to be a treatment option capable of producing a decrease in pain in patients with NSLBP. However, these results should be interpreted with caution due to the high heterogeneity in the meta-analysis.

The difference in training volumes could explain this high heterogeneity, e.g., the studies conducted by Nambi's group performed a protocol of 20 sessions, consisting of three sets of 15 repetitions at velocities of 60°/s, 90°/s, and 120°/s, which gives a total volume of 2700 repetitions in the entire intervention, compared to 900 total repetitions for Olivier et al. [49], 248 repetitions for Calmels et al. [22], and 450 total repetitions for Sertpoyraz et al. [52]. In addition to the training volume differences, it is essential to note that the trained population in the four studies by Nambi et al. [46–48,50] corresponds to young male soccer players (18 to 25 years old), which may not be representative of the general population affected by LBP, while the rest of the articles considered non-athlete patients, male and female, of mid-age (38 to 43 years old) people [22,49,52]. These differences are essential to consider because they have several confounding factors (e.g., training history, acute training response, pain response, perception, etc.) and can explain the high heterogeneity in the meta-analysis.

A network meta-analysis by Owen et al. [54] attempted to determine the best exercise mode to treat LBP. The results show that Pilates, motor control, and exercise-based or aerobic training decrease pain. However, these results have high heterogeneity and low quality of evidence. Another network meta-analysis conducted by Gianola et al. [55] concluded that pain management in patients with NSLBP should be done with non-pharmacological treatment, in which exercise appears as the best alternative to reduce pain at immediate follow-up. Thus, exercise appears to be a suitable intervention for pain management in LBP.

Although the mechanism by which IKT is effective as an intervention for LBP patients is not known, we postulate that strength training with maximum load throughout the entire range of motion, as in IKT, can contribute to greater spinal stability by training the trunk muscles, which can translate into less pain for patients. However, further research is needed to understand the mechanisms underlying the decrease in pain using IKT.

We know that LBP is the leading cause of disability in the world [56]. In this review, only three studies evaluated the effects of IKT on disability. Calmels et al. report no improvement in disability, whereas de Freitas et al. [51] found a decrease in disability in both groups, with no differences. Sertpoyraz et al. [52], the only one with low RoB, reported decreased disability in the IKT and CG using the MOLBDQ. A reduction of six points in MOLBDQ is considered clinically relevant [57]. Thus, both the IKT and CG groups significantly decreased disability, 7.20 and 8.35 points, respectively, and with clinically meaningful results. Many factors can contribute to disability, such as biophysical, psychological, social, and genetic factors. Therefore, disability is not simply the result of nociceptive inputs [58]. Consequently, different types of interventions can be expected to have positive effects on disability. Thus, isokinetic trunk training could be considered a training option when the goal is to improve the disability of patients with NSLBP. It should not be ignored that these results come from only two study, so they should be interpreted with caution. Thus, further research regarding the effects of IKT on disability is needed.

Trunk muscle strength has been considered a risk factor for developing LBP [14]. In addition, we know that patients with cLBP have a decrease in lumbar extensor isokinetic strength [24]. In this review, although eight studies included a group that trained strength, only three research measured whether the IKT program affects isokinetic trunk strength. Olivier et al. [49], who added only 15 minutes daily IKT to a conventional treatment program, reported a significant increase in both groups, with differences between groups only in extensor strength at 30°/s. de Freitas et al. [51] reported an increase in peak torque only in the trunk extensors at 120°/s in the IKT ($p = 0.008$) and CG ($p = 0.005$) groups. On the other hand, Sertpoyraz et al. [52] reported significant trunk flexor and extensor strength increases at 60°/s and 90°/s in the IKT and control groups (conventional exercises). Considering the dose-response relationship in strength training [59], it is essential to note that both Olivier et al. [49] and Sertpoyraz et al. [52] considered two or three sets of strength training per velocity, which may not be sufficient to observe more significant gains in strength. Furthermore, neither Olivier et al. nor Sertpoyraz et al. considered a training period longer than four weeks, which may have been insufficient to observe differences in the effects of an isokinetic strength training program compared to CG in NSLBP patients. Tataryn et al. [16] found more significant benefits of a posterior chain strength training program than general exercises in patients with cLBP on pain, disability, and strength. They strongly recommend considering a 12- to 16-week period to optimize results on these variables in patients with cLBP. However, de Freitas et al. [51] report improvements in extensor strength at high velocities in both groups, this does not occur for flexor muscles. The authors explain this difference in using a dynamometer without gravity corrections, which resulted in patients training flexor strength in favor of gravity, which despite considering twelve weeks of training, may not constitute a mechanically optimal stimulus for strength gains.

Isokinetic muscle strength, a difference of pain intensity and disability, is an objective measure to determine the effects of an intervention. Furthermore, we know that neural adaptations predominate in the first weeks of strength training [60]; we can suggest that further research considering more extended training periods is necessary to observe the chronic effects of strength training in NSLBP patients. In addition, given the questioning regarding the lack of natural movements when using classical isokinetic dynamometers [61], we can further suggest using the new generations of dynamometers with a more functional approach [62,63]. Functional dynamometers could allow a more significant transfer of these skills to the sports and daily activities of patients with cLBP. Finally, due to the limited evidence regarding disability and trunk strength in NSLBP patients, and limited evidence in non-athletes and women regarding pain intensity, further research is needed to elucidate the role of isokinetic trunk training in subjects with NSLBP.

4.1. Study limitations

This review is not exempt from limitations, such as, for example, it only encompasses articles published between 2001 to 2022, which could have excluded some of the evidence from this review. On the other hand, it includes a small number of studies and a small number of participants. In addition, most of the included studies were conducted by the same research group [46–48,50], which evaluated only a specific type of young and athletic population, which may make it difficult to generalize the findings of this review to the rest of the patients. Despite being the same research group, the authors clarified that these were different trials with different samples. Moreover, these results should be interpreted with caution due to the high heterogeneity found, probably due to the different samples and training protocols. In addition, we did not perform the publication bias analysis since this analysis requires a minimum of 10 studies, according to the Cochrane handbook [64]. However, we can consider it a strength that there was no language restriction in the retrieved articles. Furthermore, to our knowledge, this is the first review that attempts to determine the potential role of isokinetic trunk strength training in patients with NSLBP.

5. Conclusion

Trunk IKT could be a novel clinical tool for pain management in patients with NSLBP, although evidence is scarce. In addition, few RCTs exist for IKT on disability or trunk strength in patients with NSLBP. Based on the current evidence, it is not possible to provide a clear recommendation on the effects of trunk IKT on pain, disability, and trunk strength. Therefore, further research on this topic is needed.

Ethical approval

Not applicable.

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Informed consent

Not applicable.

Conflict of interest

The authors declare that they have no conflict of interest.

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Author contribution

WR-F Conception of review, database searches, data extraction, risk of bias assessment, statistical analysis, preparation, and revision of manuscript. LC-R Conception of review, reviewed conflicts between investigators, and revision of manuscript. DM-G data extraction, statistical analysis, preparation, and revision of manuscript. AR-P Conception of review, data extraction, preparation, and revision of manuscript. DJ-M Conception of review, database searches, data extraction, risk of bias assessment, preparation, and revision of manuscript. All authors approved the final version.

Supplementary data

The supplementary files are available to download from http://dx.doi.org/10.3233/BMR-220301.

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