International Platform of Registered Systematic Review and Meta-analysis Protocols

INPLASY

Effectiveness and safety of proprioceptive training for peripheral neuropathic pain: a systematic review and meta-analysis of randomized controlled trials

INPLASY202610021

doi: 10.37766/inplasy2026.1.0021

Received: 6 January 2026

Published: 6 January 2026

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ADMINISTRATIVE INFORMATION

Support - This work was supported by the Natural Science Foundation of Xinjiang Uygur Autonomous Region (Grant No. 2022D01C276; Project title: Effects of PirB gene silencing on CIMT-induced neuroplasticity and angiogenesis after cerebral infarction).

Review Stage at time of this submission - Preliminary searches.

Conflicts of interest - None declared.

INPLASY registration number: INPLASY202610021

Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 6 January 2026 and was last updated on 6 January 2026.

INTRODUCTION

Review question / Objective To evaluate the effectiveness and safety of proprioceptive training in adults with peripheral neuropathic pain compared with control interventions, at the end of treatment and at 4–12 weeks of follow-up.

Condition being studied Peripheral neuropathic pain, defined as pain caused by a lesion or disease of the peripheral somatosensory nervous system. Conditions may include diabetic peripheral neuropathy, postherpetic neuralgia, radiculopathy with confirmed neuropathic components, postsurgical neuropathic pain, and other peripheral nerve injuries. Studies focusing exclusively on central neuropathic pain will be excluded.

METHODS

Participant or population Adults (aged 18 years or older) diagnosed with peripheral neuropathic pain, based on clinical diagnosis and/or validated diagnostic criteria or tools (e.g., DN4, painDETECT, LANSS). Participants with pain exclusively attributable to central nervous system lesions (such as post-stroke pain or spinal cord injury–related pain) will be excluded.

Intervention Proprioceptive training, defined as exercise- or rehabilitation-based interventions primarily designed to enhance proprioceptive input, joint position sense, postural control, or sensorimotor integration. Eligible interventions include proprioceptive or joint position sense training, balance or postural control training emphasizing proprioceptive feedback (e.g.,

unstable surfaces, eyes-closed conditions, or external perturbations), sensorimotor training targeting proprioceptive afferent pathways, perturbation-based training, and proprioceptive neuromuscular facilitation (PNF), provided that proprioceptive input is a core therapeutic component. Interventions must be described with sufficient detail to allow replication (e.g., frequency, duration, or total intervention period).

Comparator Control interventions may include usual care or conventional rehabilitation, health education or no intervention, sham or minimal intervention, other exercise therapies (e.g., strength, stretching, or aerobic training) that do not primarily target proprioceptive input, and pharmacological treatment, provided that medication regimens are identical between groups except for the addition of proprioceptive training.

Study designs to be included Only randomized controlled trials (RCTs) will be included. Quasi-randomized trials, non-randomized controlled studies, observational studies (cohort, case-control, cross-sectional), case series, case reports, protocols, reviews, and animal studies will be excluded.Both parallel-group and crossover RCTs will be eligible; for crossover trials, only data from the first period will be used when appropriate to avoid carryover effects.

Eligibility criteria

Inclusion criteria:
(1) Randomized controlled trials involving adults (aged ≥18 years) diagnosed with peripheral neuropathic pain;
(2) Proprioceptive training as the primary or core intervention;
(3) Comparison with control interventions, including usual care, conventional rehabilitation, health education, no intervention, sham or minimal intervention, other exercise therapies not primarily targeting proprioception, or pharmacological treatment with identical medication regimens between groups;
(4) Reporting at least one prespecified outcome related to pain intensity or other clinical outcomes;
(5) Studies published in English or Chinese.

Exclusion criteria:
(1) Studies involving participants with exclusively central neuropathic pain;
(2) Non-randomized studies, quasi-randomized trials, observational studies, case series, case reports, reviews, protocols, conference abstracts, or animal studies;
(3) Interventions without a clear proprioceptive or sensorimotor component;
(4) Duplicate publications or studies with insufficient data for outcome extraction.

Information sources The following electronic databases will be searched from inception to the present: PubMed/MEDLINE, Embase, Web of Science, the Cochrane Central Register of Controlled Trials (CENTRAL), CINAHL, and PEDro. Chinese databases including CNKI, Wanfang Data, VIP, and SinoMed will also be searched. In addition, ClinicalTrials.gov and the World Health Organization International Clinical Trials Registry Platform (WHO ICTRP) will be searched for ongoing or unpublished trials. Reference lists of included studies and relevant reviews will be manually screened to identify additional eligible studies.

Main outcome(s) Pain intensity measured by validated scales, such as the Visual Analogue Scale (VAS) or Numerical Rating Scale (NRS), assessed at the end of treatment and at follow-up (4–12 weeks).

Additional outcome(s) Secondary outcomes will include neuropathic pain–specific measures (e.g., DN4, painDETECT, LANSS), physical function or disability assessed by validated instruments (e.g., ODI, NDI, Brief Pain Inventory), quality of life (e.g., SF-36, EQ-5D), proprioceptive or sensorimotor function (e.g., joint position sense error, balance or postural control measures), and adverse events related to the intervention. Outcomes will be assessed at the end of treatment and, when available, at follow-up (4–12 weeks).

Data management All records retrieved from electronic databases will be imported into reference management software for de-duplication. After removal of duplicates, records will be managed and screened using standardized data extraction forms. Data will be stored in password-protected electronic files, with regular backups to ensure data integrity. Any modifications to extracted data will be documented, and a final dataset will be archived for transparency and reproducibility.

Quality assessment / Risk of bias analysis The risk of bias of included randomized controlled trials will be independently assessed by two reviewers using the Cochrane Risk of Bias 2 (RoB 2) tool. The following domains will be evaluated: bias arising from the randomization process, bias due to deviations from intended interventions, bias due to missing outcome data, bias in measurement of the outcome, and bias in selection of the reported result. Each domain will be judged as “low risk of

bias," "some concerns," or "high risk of bias." Any disagreements will be resolved through discussion or consultation with a third reviewer.

Strategy of data synthesis Where sufficient data are available, quantitative synthesis (meta-analysis) will be performed. Continuous outcomes measured using the same scale will be pooled as mean difference (MD), while outcomes measured using different scales will be pooled as standardized mean difference (SMD), both with 95% confidence intervals. Meta-analyses will be conducted using a random-effects model due to anticipated clinical and methodological heterogeneity. Statistical heterogeneity will be assessed using the I^2 statistic, with values of approximately 25%, 50%, and 75% representing low, moderate, and high heterogeneity, respectively.
Separate meta-analyses will be conducted for outcomes assessed at the end of treatment and at follow-up (4–12 weeks). If quantitative synthesis is not appropriate, a narrative synthesis will be provided.

Subgroup analysis
If sufficient data are available, subgroup analyses will be performed to explore potential sources of heterogeneity according to:
(1) type of peripheral neuropathic pain (e.g., diabetic peripheral neuropathy vs postherpetic neuralgia);
(2) type of proprioceptive training (e.g., balance-based training, sensorimotor training, or proprioceptive neuromuscular facilitation); and
(3) duration of intervention (≥8 weeks vs <8 weeks).
Subgroup analyses will be conducted only when at least two studies are available per subgroup.

Sensitivity analysis Sensitivity analyses will be conducted, when appropriate, to examine the robustness of the pooled results. These analyses will include excluding studies judged to be at high risk of bias and repeating the meta-analysis using alternative statistical models (e.g., fixed-effects model). Sensitivity analyses will be performed only when sufficient studies are available.

Language restriction Studies published in English or Chinese will be included.

Country(ies) involved China.

Other relevant information This review will be conducted and reported in accordance with the PRISMA 2020 guidelines. Any deviations from the registered protocol will be documented and justified in the final publication. Only published aggregate data will be used, and no individual participant data will be collected. Ethical approval is not required for this study.

Keywords Peripheral neuropathic pain; Proprioceptive training; Proprioception; Sensorimotor training; Randomized controlled trials.

Dissemination plans The findings of this systematic review and meta-analysis will be submitted for publication in a peer-reviewed international journal in the fields of rehabilitation, pain medicine, or neurology.

Contributions of each author
Author 1 - Ruisi Tian - Methodology.
Author 2 - Yanxia Li - Data extraction.
Author 3 - Shalamaiti Amuti - Risk of bias assessment.