Online-Journals.org

iJOE International Journal of Online and Biomedical Engineering

iJOE | eISSN: 2626-8493 | Vol. 22 No. 11 (2026) | OPEN ACCESS

https://doi.org/10.3991/ijoe.v22i11.63867

PAPER

Rethinking Piriformis Syndrome Management: An Evidence-Based Synthesis of Treatment Effectiveness and Clinical Outcomes

Alif Noeriyanto Rahman[1,2] (✉), **Setiawan**[3], **Herry Herman**[1,4], **Irma Ruslina Defi**[5], **Florencia Wirawan**[2]

[1]Universitas Padjadjaran, Bandung, West Java, Indonesia

[2]Universitas Pendidikan Indonesia, Bandung, West Java, Indonesia

[3]Universitas Padjadjaran, Jatinangor, West Java, Indonesia

[4]RS UNPAD University Hospital, Jatinangor, West Java, Indonesia

[5]Universitas Padjadjaran/ Hasan Sadikin General Hospital, Bandung, West Java, Indonesia

alif23004@mail.unpad.ac.id

ABSTRACT

Piriformis syndrome management involves heterogeneous interventions and limited comparative evidence. This systematic literature network analysis (SLNA) combined a PRISMA-informed narrative synthesis with keyword co-occurrence mapping to appraise treatment evidence and locate research gaps. Scopus was searched for English-language publications from 2021 to September 2025. Of 106 retrieved records, seven publications were retained for qualitative review (five randomized controlled trials, one retrospective cohort, and one prior systematic review); the 106-record corpus informed bibliometric mapping using VOSviewer. Controlled investigations reported improvements in pain after shockwave therapy, image-guided injections, manual therapy, and exercise-based approaches, although between-treatment effects varied and follow-up was generally short. Six keyword clusters emphasized pain management, diagnosis, anatomy, and rehabilitation. Network interpretation and clinical synthesis jointly indicated insufficient longitudinal outcomes, direct comparative trials, economic evaluations, and patient-reported outcomes. Importantly, the prior review was treated as secondary evidence rather than an independent participant sample. Because of risk-of-bias concerns, heterogeneous measurements, and a single-database search, neither intervention superiority nor universal effectiveness can be established. SLNA can guide research priorities, but treatment choices should remain individualized pending better direct evidence.

KEYWORDS

Piriformis syndrome, systematic literature network analysis (SLNA), rehabilitation, bibliometric analysis, clinical outcomes

1 INTRODUCTION

Piriformis syndrome is associated with deep gluteal pain and possible sciatic nerve irritation, but its diagnostic boundaries overlap with other causes of posterior

Rahman, A. N., Setiawan, Herman, H., Defi, I. R., Wirawan, F. (2026). Rethinking Piriformis Syndrome Management: An Evidence-Based Synthesis of Treatment Effectiveness and Clinical Outcomes. *International Journal of Online and Biomedical Engineering (iJOE)*, 22(11), pp. 191–204. https://doi.org/10.3991/ijoe.v22i11.63867

Article submitted 2026-08-10. Revision uploaded 2026-10-03. Final acceptance 2026-10-20.

© 2026 by the authors of this article. Published under CC-BY.

hip and leg pain. Clinical features have been synthesized by Hopayian et al. [1], [2], while anatomy, diagnosis, and therapeutic uncertainty were reviewed by Probst et al. [3]. Management includes physical therapy and exercise, manual techniques, extracorporeal shockwave therapy (ESWT), and injection-based interventions. Evidence on these options is fragmented because comparison groups, diagnostic criteria, treatment doses, and follow-up intervals differ.

Evidence syntheses of botulinum toxin [4], shockwave interventions for related musculoskeletal pain [5], chronic low-back pain [6], and acupuncture research protocols [7] provide context but cannot establish a definitive sequence of care for piriformis syndrome. Reviews combining rigorous screening with bibliometric mapping can evaluate the clinical evidence and identify underexamined research themes. Methodological foundations include bibliometric guidance [8], [9], the VOSviewer mapping approach [10], and integrated bibliometric–systematic review methodology [11]. Sikandar et al. combined systematic and bibliometric approaches to analyze digital healthcare research [21]; it is methodologically relevant but not treatment evidence for piriformis syndrome.

The present study addresses three questions: (1) What do controlled clinical comparisons suggest about pain, function, and safety? (2) How is the broader 2021–2025 research landscape organized? (3) Which gaps emerge when the clinical evidence is compared with keyword networks? The online and biomedical-engineering relevance concerns evidence mapping, imaging-guided interventions, and opportunities for technology-assisted rehabilitation, not the testing of a new device.

Earlier assessments of piriformis syndrome emphasized variability in the diagnostic phenotype and the absence of definitive high-quality treatment comparisons [1–4]. The distinctive contribution proposed here is a dual description of treatment evidence and the terms that organize the contemporary literature. Bibliometric visualization has been used across disciplines to illustrate patterns of research attention, though it should not substitute for clinical evidence appraisal [8–11]. Relevant biomedical-engineering publications concern digital health technologies, tele-rehabilitation, activity sensing and rehabilitation software [21]–[25]; they motivate possible future tools, without offering direct effectiveness evidence in piriformis syndrome.

2 MATERIALS AND METHODS

2.1 Design and sources

A systematic literature network analysis (SLNA) combined a PRISMA 2020-informed review [12] with bibliometric keyword mapping. The search was limited to Scopus records published from January 2021 to September 2025, in English, within medicine or health professions. The query was TITLE-ABS-KEY (“piriformis syndrome”) AND TITLE-ABS-KEY (treatment OR therapy OR intervention OR management OR “physical therapy” OR “manual therapy” OR exercise OR injection OR “botulinum toxin” OR “shock wave” OR ESWT OR corticosteroid OR rehabilitation). Articles and reviews were retained at retrieval. The review was not prospectively registered. The search strategy, its date boundary, and single-database restriction constrain completeness.

This evidence review asked which conservative, injection, exercise and shockwave approaches have comparative evidence for adults with clinically identified piriformis syndrome; how the reported outcomes and harms differ by intervention; and which gaps are apparent when those studies are interpreted alongside the Scopus keyword network. The main outcome was pain intensity, with function, quality of life, satisfaction and adverse events treated as secondary domains. Controlled trial,

comparative observational and review sources were recorded by design rather than treated as one pooled population.

2.2 Study selection, extraction, and appraisal

The review applied PICO eligibility: adults with clinically identified piriformis syndrome; conservative or injection treatments; active, placebo, usual-care, or no-treatment comparators; and quantitative pain or functional outcomes. Comparative randomized and observational studies were eligible. A prior systematic review was retained as contextual secondary evidence only; it was not pooled as an additional independent clinical cohort. The source manuscript reports duplicate reviewer screening and extraction, but the identities and reconciliation log are not available for independent verification. Risk of bias was described using RoB 2 for randomized trials [13], ROBINS-I for the cohort, and AMSTAR 2 for the secondary review [14]. The source reported narrative GRADE judgments; these should be regarded as provisional until outcome-specific evidence profiles can be checked.

The documented PRISMA counts were 106 retrieved, zero duplicates, 78 excluded by title/abstract, 28 assessed in full text, 21 excluded, and seven retained. The seven consisted of five randomized trials, one retrospective cohort, and one published review. The last category is methodologically distinct, which restricts any claim about aggregate participant numbers. Narrative synthesis was used because intervention categories, measurement scales, and assessment times were not sufficiently comparable for a defensible meta-analysis.

2.3 Network mapping and integration

The complete 106-record retrieval set informed keyword co-occurrence mapping using VOSviewer 1.6.19 [10]. Author and indexed keywords were included with a minimum occurrence threshold of two. The manuscript reported six clusters, 89 terms, and 847 links. Clinical findings and network positions were compared descriptively to identify convergence and divergence. Strategic quadrant scores reported in the underlying manuscript were interpreted as exploratory theme-position indicators, not standardized clinical effect measures. No independent reanalysis of the original Scopus export was available for this condensed manuscript.

2.4 Synthesis decisions and reporting boundaries

Clinical evidence and keyword-network evidence were deliberately maintained as separate streams before interpretation. Clinical findings were ordered by intervention and comparator, design, follow-up and risk of bias, with no pooled meta-analysis because of marked heterogeneity. Network clusters were used to identify visibility and connectivity of research subjects rather than to generate therapeutic effect estimates. Convergence was interpreted as a correspondence between thematic attention and measured outcomes; divergence described clinically relevant topics that were weakly represented in the mapped record set.

The original review materials did not establish a reconciled count of unique primary-study participants, a complete full-text eligibility audit, or an independently reproducible VOSviewer dataset. These unresolved methodological limitations are explicitly distinguished from the reported results; confirmation against primary records is necessary before a definitive clinical synthesis can be claimed.

3 RESULTS

3.1 Study profile and selection

Five randomized trials addressed ESWT versus corticosteroid injection, multimodal injection therapy, manual techniques, and therapeutic exercise. A retrospective cohort concerned botulinum toxin in image-guided intervention, while a systematic review summarized previous botulinum toxin studies [4]. Although the source abstract refers to 423 participants, its reported study table includes 68 + 35 + 60 + 40 + 63 + 194 = 460 participants across the six primary studies; the review separately summarizes 152 participants, potentially overlapping other studies (see Table 1). Therefore, no combined participant total is asserted here pending source verification.

Table 1. Originally included-publication profile (sample sizes and designs as transcribed; verify against full texts)

Study	Design; N	Intervention and Comparison	Follow-Up
Fu et al. (2026; online 2025) [16]	RCT; 68	Focused ESWT vs. ultrasound-guided corticosteroid	5 weeks
Ahadi et al. (2023) [17]	RCT; 35	Radial ESWT vs. corticosteroid	12 weeks
Elsawy et al. (2023) [18]	RCT; 60	Botulinum toxin + ozone + lidocaine vs. lidocaine	6 months
Danazumi et al. (2021) [15]	RCT; 40	INIT vs. positional release technique	6 weeks
Ergezen et al. (2023) [20]	RCT; 63	Self-myofascial release + strengthening vs. stretching + strengthening	6 weeks
Yan et al. (2021) [19]	Cohort; 194	Botulinum toxin + image-guided injection vs. non-BTX approach	Variable
Koh and Tan (2022) [4]	Systematic review; 152 (reported)	Botulinum toxin studies; secondary synthesis	Mixed

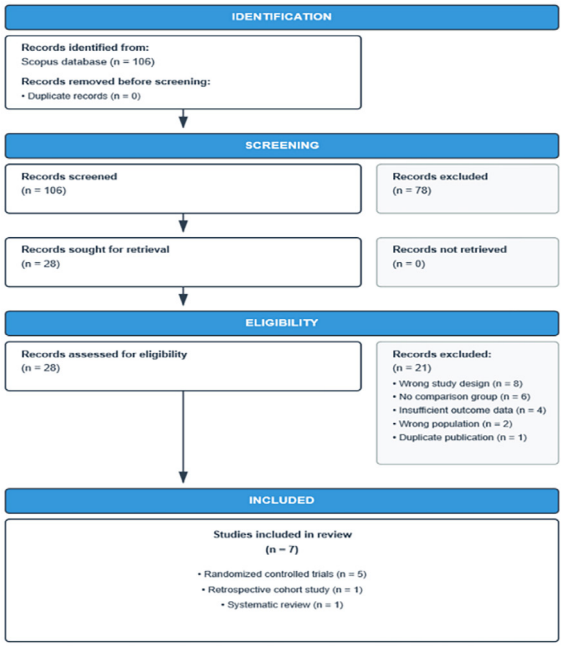


Fig. 1. PRISMA 2020 flow diagram

The original PRISMA flow (106 → 28 → 7) is numerically consistent, but source-study classification should be checked: a systematic review does not constitute an independent controlled trial. The search and screening log, excluded-study reasons, and reviewer identities should accompany a future reproducible submission

From 106 retrieved records, the original screening diagram indicates 78 exclusions at title-and-abstract review, followed by 28 full-text assessments and 21 exclusions, producing seven included publications. The reported full-text exclusions concern study design, missing comparison arms, inadequate outcomes, population mismatch and duplicate publication. The counts can be carried forward as the authors' reported workflow, but independent confirmation requires the screening spreadsheet and the full bibliographic list. Figure 1 reproduces the numerical flow in a compact editable presentation.

3.2 Treatment effectiveness and safety

Treatment responses differed by intervention and comparison. Danazumi et al. [15] reported a larger within-group reduction in visual analog scale (VAS) pain with integrated neuromuscular inhibition technique (from 6.9 to 1.9) than with positional release (from 7.0 to 3.3), based on the source manuscript. Two ESWT comparisons [16], [17] described improvement in both study groups, although the source stated no significant between-group difference at five weeks for focused ESWT versus steroid injection. Injection studies [18], [19] and the secondary synthesis [4] suggested potential benefit, but intervention mixtures and study overlaps prevent direct ranking. The exercise trial [20] was presented with incomplete numerical extraction in the original manuscript, so no precise comparative estimate can be recovered here.

Functional outcomes were less consistently reported than pain. Some controlled studies documented disability improvement alongside pain improvement, but scales and time points differed. Adverse-event reporting appeared reassuring in the selected publications; however, the lack of reported serious events in small, short-follow-up studies is not sufficient to demonstrate a universally excellent safety profile. The dataset does not support pooled adverse-event incidence, a universal clinical minimal-important-difference claim, or high-certainty evidence for a treatment hierarchy.

Table 2. Evidence synthesis and interpretive limits

Modality	Observed Direction in Selected Reports	Interpretive Constraint
ESWT	Pain decreased in intervention arms [16], [17]	Direct comparisons yielded mixed/ limited superiority signals
Manual therapy	INIT and positional release improved reported VAS [15]	Single small trial and short follow-up
Injection approaches	Favorable findings in some comparisons [4], [18], [19]	Mixed injectates; nonrandomized cohort; overlapping review
Exercise	Improvement reported [20]	Numerical outcomes incompletely available in source
Safety/function	Functional gains and few reported severe events	Underpowered, inconsistent follow-up and adverse-event ascertainment

Five records were classified as randomized controlled trials in the submitted study table; other eligible records included an observational cohort and a systematic review (see Table 2). The source appraisal identified one low-risk RCT, several RCTs with some concerns and one high-risk report, with nonrandomized and review evidence considered separately. Such a small, mixed-design set cannot supply reliable,

pooled safety estimates or strong comparative certainty. Particularly important are uncertain allocation procedures, selective reporting, and inconsistency in study-level sample-size definitions.

Results can be interpreted at three distinct levels: (1) whether pain improved within a treatment arm; (2) whether one treatment outperformed its stated comparator; and (3) whether results are robust across settings and patient groups. The first level does not establish the second, and neither guarantees the third. The present narrative synthesis therefore reports direction and comparative limits while avoiding newly computed effect sizes not traceable to the uploaded extraction data.

3.3 Keyword landscape and research gaps

The source co-occurrence mapping described six thematic groups: clinical management and pain (approximately 40%), diagnostic and imaging (22%), anatomical/surgical (18%), conservative treatment (12%), methods (5%), and specialized interventions (3%). The largest nodes included "piriformis syndrome," "pain," "human," and "adult." These proportions describe mapped keywords or cluster membership, not a distribution of patient outcomes. Clinical research and diagnostic imaging were prominent, while long-term outcomes, economic evaluation, and patient experience were less visible.

Table 3. Convergent research-gap matrix based on the reported SLNA findings

Gap	Clinical Review Signal	Network Signal/Research Priority
Long-term durability	Most investigations assessed short follow-up	Peripheral themes; 12–24-month prospective follow-up
Head-to-head effectiveness	Few direct multi-intervention comparisons	Compare active treatment pathways with standardized diagnosis
Protocol optimization	Different doses and procedures	Evaluate dose, timing, adherence, and technique
Economic evaluation	No dedicated cost-effectiveness analysis in retained evidence	Add cost–utility and resource-use outcomes
Patient-centered outcomes	Infrequent standardized quality-of-life assessment	Develop core outcomes and acceptability measures

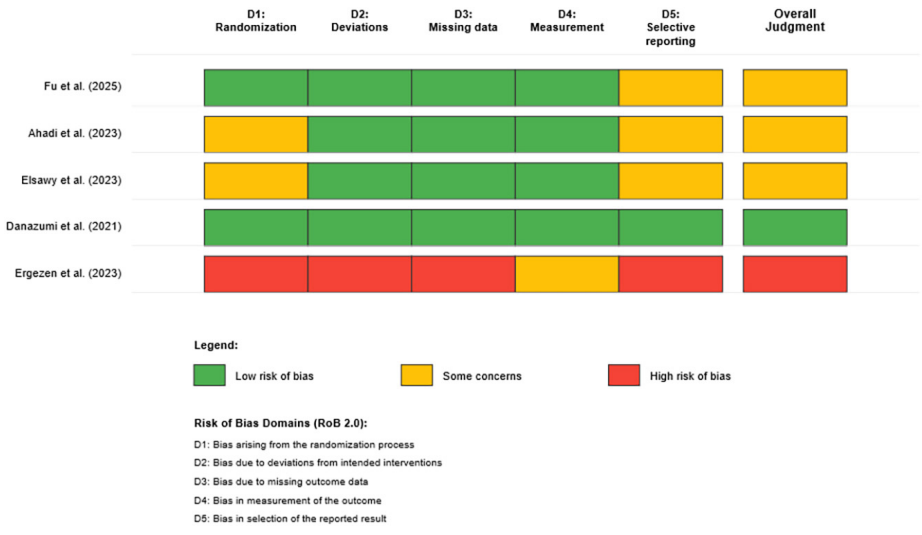


Fig. 2. Risk of bias summary for randomized controlled trials

Remote physiotherapy delivery for musculoskeletal conditions was reviewed by Husaain et al. [22]; wearable gait monitoring was developed by Astudillo et al. [23]; sensor-based rehabilitation tools were presented by Luque-Milera et al. [24]; and a remote rehabilitation application was developed by Suarez-Sotelo et al. [25]. Their relevance is to longitudinal monitoring, adherence, access, and outcome measurement, which should be evaluated in future piriformis trials rather than assumed effective in this condition.

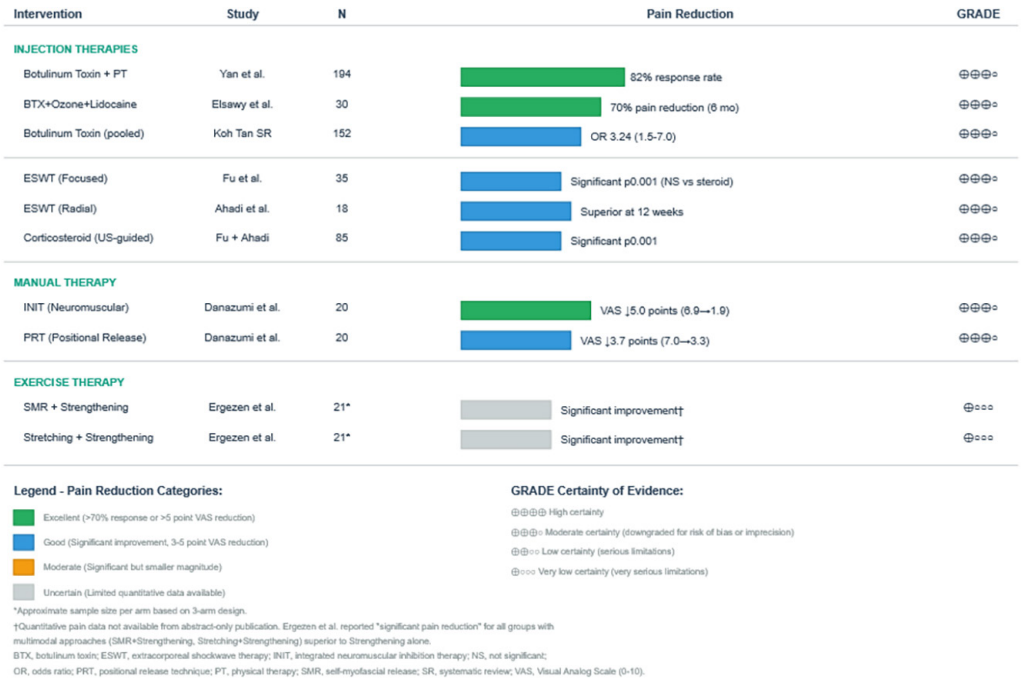


Fig. 3. Treatment effectiveness: Pain reduction outcomes

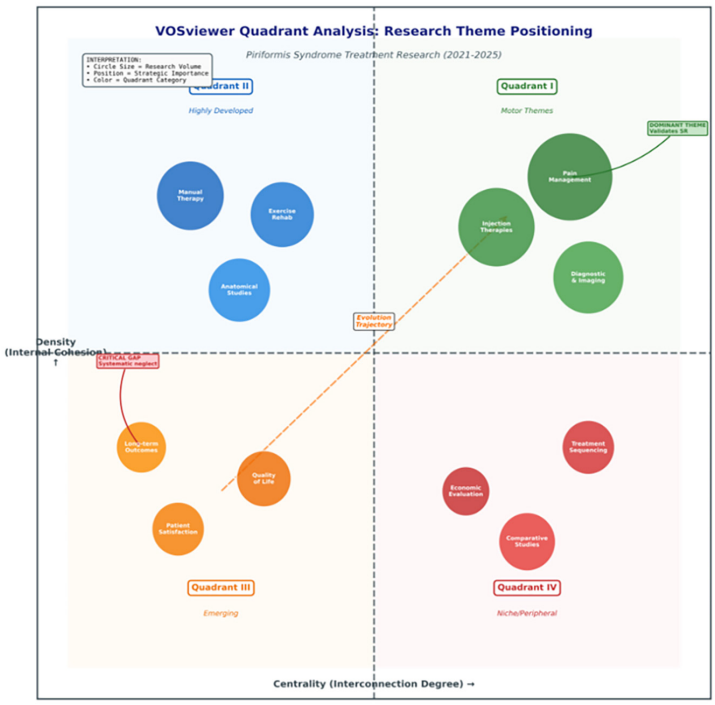


Fig. 4. Strategic theme positioning: Quadrant analysis

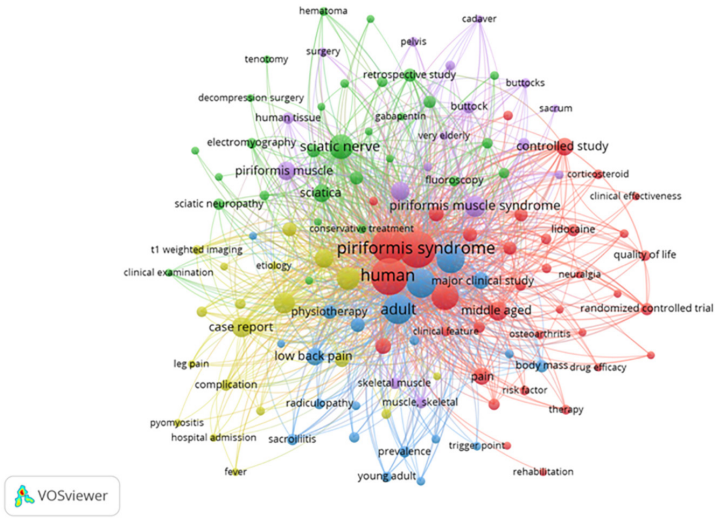


Fig. 5. Temporal overlay of research evolution in piriformis syndrome (2022–2024)

3.4 Strategic quadrant positioning and integrated gaps

The original manuscript organizes themes in a centrality–density plane. Pain management and clinical effectiveness, injection therapy, and imaging are displayed as influential well-developed areas; rehabilitation and manual techniques as relatively specialized; long-term outcomes, satisfaction and quality of life as weakly developed; and economic evaluation, treatment sequencing and direct effectiveness comparison as connected but less cohesive. Figure 4 preserves that descriptive research-planning illustration, subject to verification of coordinates against the underlying network file.

Across the clinical and bibliometric components, the strongest practical research priorities are (i) longer follow-up beyond the acute response window, (ii) direct comparisons using shared outcomes, (iii) better characterization of doses and co-interventions, (iv) cost and resource evaluation, and (v) patient-centered reporting. These priorities reflect the limited evidence base and the low visibility of selected themes in the supplied network interpretation; they are not numerical probabilities of intervention success.

4 DISCUSSION

The principal synthesis finding is the coexistence of promising short-term symptom improvement and substantial uncertainty about comparative treatment performance. The qualitative evidence does not support the source manuscript's initial universal-effectiveness or absolute-safety language: results from within-group changes cannot establish superiority over a comparator, and no serious events reported is not proof of no risk. The strongest practical implication is that treatment decisions should consider symptom burden, diagnosis, patient preferences, available expertise, and intervention-related risks while awaiting stronger randomized comparisons.

4.1 Clinical interpretation across interventions

The head-to-head evidence is heterogeneous. In the comparison summarized for Danazumi et al. [15], integrated neuromuscular inhibition and positional release each

reduced reported pain, with a larger within-study reduction in the former arm. That result should be read in its intervention setting and follow-up window. Studies of focused or radial shockwave versus injection approaches [16], [17] used different doses and endpoints, limiting indirect ranking. Multimodal injection comparisons [18] cannot isolate the contribution of each component without appropriate factorial contrasts.

Patient-valued effectiveness is broader than change in a visual analog score. A clinically useful evaluation should prespecify function, activity limitations, ability to work, sleep, adverse events, treatment burden, acceptability and sustained improvement. Observed group-level means changes may conceal substantial variation in individual response. Clinical minimal-important-difference thresholds also depend on baseline severity, scale and patient context. Accordingly, evidence supports further comparative trials rather than a universal algorithm or proof that one modality dominates.

The network results are contextualized rather than validate clinical estimates. A strongly connected pain-management cluster is consistent with common pain outcomes in trials; it does not independently confirm effect sizes, clinical utility, or low risk of bias. Similarly, exploratory centrality–density quadrant coordinates can prioritize investigation but require transparent definitions and reproducible mapping if used quantitatively. Previous guidance on co-word and bibliometric analysis [8–11] underscores the importance of preprocessing, sensitivity analyses, and complete reporting. The original SLNA gap framework contained an unresolved participant total and is omitted here until the screening and primary-study counts are reconciled.

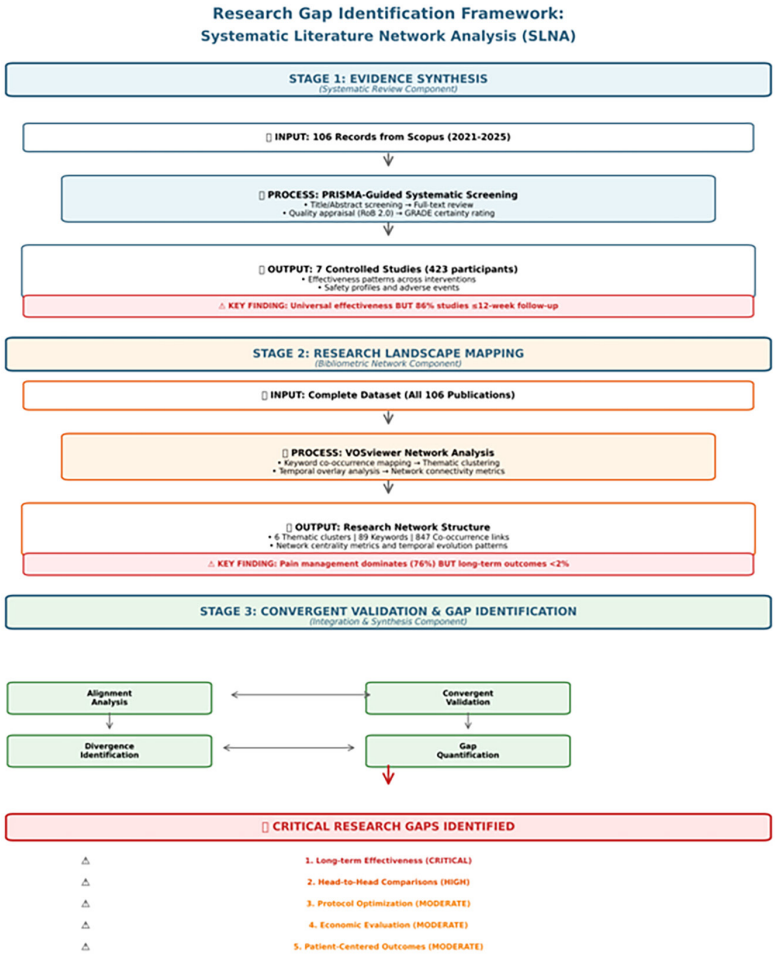


Fig. 6. SLNA gap identification framework

4.2 Bibliometric interpretation and technology implications

Keyword co-occurrence networks measure how often indexed terms appear together, and are influenced by indexing conventions, threshold choices, synonymous terminology, and database coverage [8–11]. A large pain-management node indicates thematic prominence but does not provide a second independent estimate of therapeutic efficacy. Similarly, the apparent absence of a keyword such as cost-effectiveness is not definitive proof that no source considered financial aspects; abstracts and full texts must also be checked.

The manuscript's strategic diagram assigns motor status to pain management, injections and imaging; specialized status to manual therapy and rehabilitation; emerging status to long-term outcomes and patient experience; and transversal status to treatment sequencing and economic evaluation. These are useful descriptive hypotheses, not validated clinical categories. Because the supplied file does not include a network export from which the numerical centrality and density coordinates can be recalculated, the diagram should be described as exploratory until its generation procedure is disclosed.

The healthcare-technology literature strengthens the manuscript's connection to online and biomedical engineering: systematic bibliometric mapping of healthcare technologies [21], musculoskeletal tele-physiotherapy [22], wearable rehabilitation monitoring [23], force-sensing systems [24], and patient-centered rehabilitation software [25] indicate feasible modalities for tracking adherence, function, and experience. None directly establishes clinical effectiveness for piriformis syndrome. Future studies might combine validated pain and disability scales with digital monitoring, while addressing accessibility, privacy, device measurement accuracy, and equitable participation.

4.3 Methodological limitations

The literature-search approach is reproducible only in part. Its Scopus syntax and major eligibility fields are available, but the precise search date, downloaded records, exclusion decisions, versioned thesaurus, and raw bibliometric input are not attached to the supplied manuscript. Scopus-only coverage and restrictions to English publications and years 2021–2025 create selection risks. Full assessment requires confirmation of study-level extraction against original articles, particularly when a source is an abstract rather than an eligible full report.

Different analytical units should not be conflated. Seven included publications do not represent seven independent controlled clinical trials because one is a systematic review. Counts from that review may overlap with participants in other reports or older primary studies. Its pooled outcomes are secondary evidence, not additional independent patients. The original source alternates between 423 and larger aggregate counts, so participant totals and numerical synthesis should not be interpreted as verified until an auditable primary-study roster is completed.

RoB 2 applies to randomized trials [13], whereas cohort studies require a suitable non-randomized assessment and existing systematic reviews require review-level appraisal such as AMSTAR 2 [14]. Broad GRADE labels should be attached to specific intervention-comparator-outcome-timepoint questions, not to modalities in the abstract. Where original trials do not report effect estimates, confidence intervals,

or adverse-event denominators, the appropriate finding is insufficient information rather than evidence of equivalence or exceptional safety.

Several limitations govern inference. Searching only Scopus and English-language records risks omitted studies; the 2021–2025 restriction excludes older comparative trials. Clinical diagnosis and interventions were heterogeneous; one eligible item was itself a review, and participant totals in the source manuscript were inconsistent. A trial labelled high risk in the source was also described as abstract-only despite requiring full texts. The lack of raw extraction sheets, complete GRADE evidence profiles, and reproducible keyword exports means numeric estimates and network-derived prioritization cannot be independently audited here. The bibliometric corpus and controlled-study subset answer different questions and must remain analytically separate.

Future studies should prespecify consistent diagnostic criteria and clinically important outcomes, use adequately powered head-to-head randomization, collect harms systematically, and provide follow-up for at least 12 months where feasible. Health-economic outcomes and patient-reported experiences should be included prospectively. Transparent search exports, deduplication logs, full-text screening decisions, and open network parameters would improve reproducibility.

4.4 Implications for research and digital rehabilitation

Clinical and digital measurement programs can be developed alongside comparative treatment studies without presuming that technology itself improves clinical outcomes. Wearable sensing may help characterize activity and functional recovery, while remote physiotherapy platforms could facilitate follow-up outside hospital settings [22–25]. Feasibility, acceptability, data reliability, access equity, and clinical efficacy require separate evaluation. Continuous collection of pain trajectories, disability scores, return-to-work status, satisfaction, and adverse events would address gaps identified in both the clinical synthesis and network mapping.

For practice guidelines, a treatment pathway should begin with diagnostic re-evaluation and patient priorities rather than a rigid ranking inferred from indirect comparisons. The included comparisons differ in dose, population, clinician expertise and follow-up. Economic evaluations may incorporate visits, equipment, medication, procedural costs, time away from work, and patient-borne expenses. Multicentre implementation designs would improve transferability while permitting harmonized definitions of both benefit and harm.

5 CONCLUSION

This SLNA indicates that several conservative and injection-based interventions are associated with short-term pain improvement in the identified literature, but the evidence is too heterogeneous for confident treatment ranking or universal safety claims. Keyword mapping highlights an emphasis on immediate pain management and less developed evidence for long-term outcomes, direct comparisons, costs, and patient experience. Research combining rigorous comparative trials with validated biomedical and remote-rehabilitation measurements may close these gaps. These findings support individualized care and better evidence generation, not endorsement of a single preferred modality.

6 DECLARATIONS

Ethics statement: This study synthesized previously published literature and did not recruit participants or collect new identifiable patient data. Funding: To be confirmed by all authors before submission. Conflicts of interest: To be declared by all authors before submission. Data availability: The Scopus export, study-screening log, extraction sheets, and VOSviewer project files should be made available in a repository or under an accurate access statement. Author contributions: To be confirmed by the authors. [AUTHOR CONFIRMATION REQUIRED: Do not submit this placeholder declaration.]

6.1 Declaration of generative AI and AI-assisted technologies in the writing process

Artificial intelligence (AI) tools, specifically Claude (Anthropic, Sonnet 4) and ChatGPT (OpenAI), were employed exclusively to support linguistic refinement, grammatical accuracy, and clarity of academic presentation during manuscript preparation. Their use was limited to editorial assistance and did not influence the study design, methodological procedures, data extraction, bibliometric analysis, interpretation of findings, or scientific conclusions. All AI-assisted revisions were critically evaluated and verified by the authors to ensure consistency with the original research evidence and adherence to standards of scientific integrity and publication ethics. The authors retain full intellectual responsibility and accountability for the accuracy, originality, and integrity of the final manuscript.

7 REFERENCES

[1] K. Hopayian, F. Song, R. Riera, and S. Sambandan, "The clinical features of the piriformis syndrome: A systematic review," *European Spine Journal,* vol. 19, no. 12, pp. 2095–2109, 2010. https://doi.org/10.1007/s00586-010-1504-9

[2] K. Hopayian and A. Danielyan, "Four symptoms define the piriformis syndrome: An updated systematic review of its clinical features," *European Journal of Orthopaedic Surgery & Traumatology,* vol. 28, no. 2, pp. 155–164, 2018. https://doi.org/10.1007/s00590-017-2031-8

[3] D. Probst, A. Stout, and D. Hunt, "Piriformis syndrome: A narrative review of the anatomy, diagnosis, and treatment," *PM&R,* vol. 11, no. S1, pp. S54–S63, 2019. https://doi.org/10.1002/pmrj.12189

[4] M. M. Koh and Y. L. Tan, "Use of botulinum neurotoxin in the treatment of piriformis syndrome: A systematic review," *Pain Medicine,* vol. 23, no. 9, pp. 1589–1598, 2022. https://doi.org/10.1093/pm/pnac027

[5] H. De la Corte-Rodríguez, J. M. Román-Belmonte, B. A. Rodríguez-Damiani, A. Vázquez-Sasot, and E. C. Rodríguez-Merchán, "Extracorporeal shock wave therapy for the treatment of musculoskeletal pain: A narrative review," *Healthcare,* vol. 11, no. 21, Art. no. 2830, 2023. https://doi.org/10.3390/healthcare11212830

[6] K. Liu *et al.*, "Efficacy and safety of extracorporeal shockwave therapy in chronic low back pain: A systematic review and meta-analysis of 632 patients," *Journal of Orthopaedic Surgery and Research,* vol. 18, no. 1, Art. no. 455, 2023. https://doi.org/10.1186/s13018-023-03943-x

[7] Y. He *et al.*, "Acupuncture methods for piriformis syndrome: A protocol for systematic review and network meta-analysis," *Journal of Pain Research,* vol. 16, pp. 2357–2364, 2023. https://doi.org/10.2147/JPR.S417211

[8] N. Donthu, S. Kumar, D. Mukherjee, N. Pandey, and W. M. Lim, "How to conduct a bibliometric analysis: An overview and guidelines," *Journal of Business Research,* vol. 133, pp. 285–296, 2021. https://doi.org/10.1016/j.jbusres.2021.04.070

[9] I. Zupic and T. Čater, "Bibliometric methods in management and organization," *Organizational Research Methods,* vol. 18, no. 3, pp. 429–472, 2014. https://doi.org/10.1177/1094428114562629

[10] N. J. van Eck and L. Waltman, "Software survey: VOSviewer, a computer program for bibliometric mapping," *Scientometrics*, vol. 84, no. 2, pp. 523–538, 2010. https://doi.org/10.1007/s11192-009-0146-3

[11] G. Marzi, M. Fakhar Manesh, A. Caputo, M. M. Pellegrini, and B. Vlačić, "Guidelines for bibliometric-systematic literature reviews: 10 steps to combine analysis, synthesis and theory development," *International Journal of Management Reviews,* vol. 27, no. 1, pp. 3–34, 2024. https://doi.org/10.1111/ijmr.12381

[12] M. J. Page *et al.*, "The PRISMA 2020 statement: An updated guideline for reporting systematic reviews," *BMJ,* vol. 372, Art. no. n71, 2021. https://doi.org/10.1136/bmj.n71

[13] J. A. C. Sterne *et al.*, "RoB 2: A revised tool for assessing risk of bias in randomised trials," *BMJ*, vol. 366, Art. no. l4898, 2019. https://doi.org/10.1136/bmj.l4898

[14] B. J. Shea *et al.*, "AMSTAR 2: A critical appraisal tool for systematic reviews that include randomised or non-randomised studies of healthcare interventions, or both," *BMJ*, vol. 358, Art. no. j4008, 2017. https://doi.org/10.1136/bmj.j4008

[15] M. S. Danazumi, A. M. Yakasai, A. A. Ibrahim, U. T. Shehu, and S. U. Ibrahim, "Effect of integrated neuromuscular inhibition technique compared with positional release technique in the management of piriformis syndrome," *Journal of Osteopathic Medicine*, vol. 121, no. 8, pp. 693–703, 2021. https://doi.org/10.1515/jom-2020-0327

[16] Y.-S. Fu *et al.*, "Efficacy of ultrasound-guided piriformis muscle corticosteroid injection versus extracorporeal shockwave therapy in patients with piriformis syndrome: A randomized controlled trial," *Journal of the Formosan Medical Association*, vol. 125, no. 4, pp. 391–397, 2026. https://doi.org/10.1016/j.jfma.2025.01.020

[17] T. Ahadi, A. Yousefi, S. Sajadi, N. Yousefi, and A. Babaei-Ghazani, "Comparing radial extracorporeal shockwave therapy and corticosteroid injection in the treatment of piriformis syndrome: A randomized clinical trial," *Journal of Bodywork and Movement Therapies,* vol. 33, pp. 182–188, 2023. https://doi.org/10.1016/j.jbmt.2022.09.020

[18] A. G. S. Elsawy *et al.*, "Efficacy of ultrasound-guided injection of botulinum toxin, ozone, and lidocaine in piriformis syndrome," *Healthcare*, vol. 11, no. 1, Art. no. 95, 2023. https://doi.org/10.3390/healthcare11010095

[19] K. Yan, Y. Xi, R. Hlis, and A. Chhabra, "Piriformis syndrome: Pain response outcomes following CT-guided injection and incremental value of botulinum toxin injection," *Diagnostic and Interventional Radiology*, vol. 27, no. 1, pp. 126–133, 2021. https://doi.org/10.5152/dir.2020.19444

[20] G. Ergezen and M. Şahin, "Comparison of self-myofascial release and stretching exercises in individuals with piriformis syndrome: A randomised controlled trial," *International Journal of Therapy and Rehabilitation*, vol. 30, no. 11, pp. 1–10, 2023. https://doi.org/10.12968/ijtr.2023.0022

[21] H. Sikandar, A. F. Abbas, N. Khan, and M. I. Qureshi, "Digital technologies in healthcare: A systematic review and bibliometric analysis," *International Journal of Online and Biomedical Engineering,* vol. 18, no. 8, pp. 34–48, 2022. https://doi.org/10.3991/ijoe.v18i08.31961

[22] F. S. Husaain, S. Irum, M. M. K. Al.Rayes, Z. I. A. Jasim, and M. Ashfaq, "The implementation of tele-health physiotherapy services for musculoskeletal conditions: A Systematic Review," *International Journal of Online and Biomedical Engineering*, vol. 17, no. 9, pp. 70–81, 2021. https://doi.org/10.3991/ijoe.v17i09.24795

[23] A. Astudillo, E. Avella-Rodríguez, G. Arango-Hoyos, J. Ramirez-Scarpetta, and E. Rosero, "Smartphone-based wearable gait monitoring system using wireless inertial sensors," *International Journal of Online and Biomedical Engineering*, vol. 19, no. 8, pp. 38–55, 2023. https://doi.org/10.3991/ijoe.v19i08.38781

[24] B. Luque-Milera, W. K. Sánchez-Contreras, E. J. L. Florian-Amaro, E. L. Acosta-Valdez, J. M. Sanchez-Ramirez, and C. Castro-Vargas, "Design and Implementation of a force sensor glove for post-accident patient rehabilitation," *International Journal of Online and Biomedical Engineering*, vol. 21, no. 7, pp. 88–105, 2025. https://doi.org/10.3991/ijoe.v21i07.54273

[25] J. Suarez-Sotelo, D. Guillen-Ladera, C. Marrujo-Ingunza, S. Ramos-Cosi, and V. Romero-Alva, "Software design for physical rehabilitation in patients with musculoskeletal injuries," *International Journal of Online and Biomedical Engineering*, vol. 22, no. 2, pp. 90–108, 2026. https://doi.org/10.3991/ijoe.v22i02.55573

8 AUTHORS

Alif Noeriyanto Rahman is a doctoral researcher at the Doctoral Study Program in Medical Science, Faculty of Medicine, Universitas Padjadjaran, Bandung, West Java, Indonesia, and is also affiliated with the Department of Medical Science, Faculty of Medicine, Universitas Pendidikan Indonesia. His academic activities focus on medical and health sciences (E-mail: alif23004@mail.unpad.ac.id; alifrahman@upi.edu).

Setiawan is a researcher in the Physiology Division, Department of Biomedical Science, Faculty of Medicine, Universitas Padjadjaran, Jatinangor, West Java, Indonesia. His academic activities focus on physiology and biomedical sciences (E-mail: setiawan@unpad.ac.id).

Herry Herman is a researcher and medical specialist at the Department of Orthopaedic Surgery and Traumatology, Faculty of Medicine, Universitas Padjadjaran, Bandung, West Java, Indonesia, and RS UNPAD University Hospital, Jatinangor, West Java, Indonesia. His professional and academic activities focus on orthopaedic surgery and traumatology (E-mail: herry.herman@unpad.ac.id).

Irma Ruslina Defi is a researcher at the Department of Physical Medicine and Rehabilitation, Faculty of Medicine, Universitas Padjadjaran/Hasan Sadikin General Hospital, Bandung, West Java, Indonesia. Her professional and academic activities focus on physical medicine and rehabilitation (E-mail: irma.ruslina@unpad.ac.id).

Florencia Wirawan is a researcher at the Department of Medical Science, Faculty of Medicine, Universitas Pendidikan Indonesia, Bandung, West Java, Indonesia. Her academic activities focus on medical and health sciences (E-mail: florencia.wirawan@gmail.com).