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Systematic Review

The effects of core stabilizing exercise in postpartum women with lumbopelvic pain: A systematic review with meta-analysis

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ABSTRACT

Background: Previous studies have shown beneficial effects of core stabilizing exercise in postpartum lumbopelvic pain (LPP). However, effects on quality of life (QoL) and evidence certainty remain unclear.
Objective: To synthesize evidence on the effects of core stabilizing exercise on pain, disability, QoL, and core muscle contractility for postpartum LPP.
Methods: A systematic search was conducted using six databases (PubMed, Cochrane Library, Embase, CINAHL, Airiti Library, and WANFANG DATA home), covering articles published up to May 2025. Randomized and quasi-randomized controlled trials that investigated the core stabilizing exercise in postpartum LPP were included. The primary outcomes were pain, disability, and QoL. The secondary outcome was core muscle contractibility. Study quality and evidence certainty were assessed using Cochrane Risk of Bias 2.0 (RoB 2.0) and GRADE, respectively. Meta-analyses were conducted using the random-effects model.
Results: Fifteen studies were included in the meta-analysis. The results demonstrated that core stabilizing exercise significantly improved the pain (SMD = -0.80, 95 %CI: -1.15 to -0.46), disability (SMD = -0.85, 95 % CI: -1.17 to -0.54), and QoL (SMD = 0.44, 95 % CI: 0.06 to 0.82). Study quality was moderate (RoB 2.0), and evidence certainty was high for disability, moderate for pain, and low for QoL (GRADE). The evidence on core muscle contractility was inconclusive due to insufficient and inconsistent data across studies.
Conclusions: The core stabilizing exercise was effective on management of pain, disability, and QoL in postpartum LPP. Future studies with standardized measurement methods are needed to clarify the effect of core stabilizing exercise on core muscle contractibility.

Introduction

Lumbopelvic pain (LPP) includes pelvic girdle pain and low back pain, as well as a combination of both. It is a common symptom that occurs during pregnancy, and the symptoms may persist after laboring.[1] The prevalence of postpartum LPP is, on average, 24.7 %.[1] Many postpartum women experience difficulties in performing daily tasks and maintaining work ability due to LPP, which significantly impacts their quality of life (QoL).[2,3]

Physiological and musculoskeletal changes during pregnancy are related to LPP. The weight gain and gravity shifting anterior could progressive the lumbar lordosis. The increased joint laxity in the lumbar spine, pubic symphysis, and sacroiliac joints help support the growing fetus but also contributes to core instability.[4] The overstretching of the abdominal muscle can diminish core stability and contribute to low back pain.[5] While the biomechanical and hormonal changes from pregnancy are mostly recovered within three months after delivery, the reduced core stability and increased physical demand on the lower back like caring the baby may contribute to the persistent LPP in postpartum women.[3,6]

Core muscle plays an important role in core stability. It is a muscular box composed of the abdominals, paraspinal muscles, diaphragm, pelvic floor muscles (PFM), and hip muscles, which together stabilize the spine, pelvis, and kinetic chain during functional movements.[7] The core stabilizing exercise not only focuses on strengthening the core muscles, but also the integration of sensory and motor components. Previous studies have showed that core stabilizing exercises are effective in reducing pain, enhancing trunk stability, and improving Transverse Abdominis

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(TrA) muscle function in individuals with low back pain.[8–10] However, reduced core muscle function has been observed in postpartum women compared to non-pregnant women.[6] Pregnancy-related overstretching and neuromuscular adaptations may contribute to impaired core performance.[11] A knowledge gap remains exist in the effects of core stabilizing exercise on the core muscle contractibility in postpartum women with LPP.

A systematic review published in 2022 found that stabilizing exercise effectively reduced pain and disability in postpartum women with LPP but had no significant impact on QoL.[12] Due to the limited number of studies and substantial heterogeneity in participants and intervention, the findings on QoL remain inconclusive. As QoL in postpartum LPP is a significant issue associated with reduced work ability, depression, and sleep disturbances,[13] this highlights a critical knowledge gap that this systematic review aimed to update. Moreover, the certainty of evidence in the previous review was not evaluated using the GRADE approach, limiting the clinical interpretability of the findings.

Therefore, this systematic review aims to synthesize evidence from randomized and quasi-randomized controlled trials to evaluate the effects of core stabilizing exercise on pain, disability, and QoL in postpartum women with LPP. The secondary aim was to assess the effect of core stabilizing exercise on core muscle contractibility including abdominal muscles and PFM in this population, providing a more comprehensive understanding of its therapeutic benefits. Additionally, the certainty of evidence was evaluated using the GRADE approach to support clinical recommendations.

Material and methods

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to ensure transparency and reduce potential bias.[14] The review protocol was prospectively registered in PROSPERO (CRD42025631791). The authors declare that no generative artificial intelligence tools were used in the scientific writing of the study.

Data sources and search strategy

The literature search was performed across several databases, including PubMed, Cochrane Library, Embase, CINAHL, Airiti Library, WANFANG DATA home, and Google Scholar. The search strategy incorporated MeSH terms along with free-text keywords, using Boolean operators to optimize sensitivity and specificity. The detailed searching strategies are provided in Supplementary Appendix A. The search keywords were set based on participants and intervention, including postpartum period, postpartum, core stabilizing exercise, pain, disability evaluation, pelvic girdle pain, low back pain.

Study selection

Two researchers (YTY, YTL) independently screened the titles and abstracts to determine study eligibility. If there was a discrepancy between the two reviewers, a third reviewer (KYL) was consulted to reach a consensus. The inclusion criteria were defined as follows.

The included study designs were randomized and quasi-randomized controlled trials. Articles published in English and Chinese were considered, with no restrictions on publication year. Conference abstracts, study protocol, letters were excluded. Trials enrolling postpartum women aged $\geq$18 years who experienced LPP within three months after delivery were included. Eligible trial featured an intervention arm with core stabilizing exercises aimed at strengthening core muscles. Comparators include general exercise, no intervention and usual care. General exercise referred to physical activity without a specific emphasis on core activation,[15] while usual care included passive treatment such as manual therapy, electrotherapy, thermotherapy, and lumbar traction.

Outcome measurement

The primary outcomes were pain intensity, disability, and QoL measured through scales and questionnaires. For those with multiple domains in the questionnaires, the items that measured the same outcome focus on physical health were chosen. The secondary outcome was core muscle contractibility (i.e., abdominal muscles, PFM) assessed through ultrasound imaging. These muscles are considered key components of the core stability system, playing essential roles in lumbopelvic control and load transfer.[16] It has been shown that ultrasound imaging is a reliable tool to assess abdominal muscles activity in low back pain population.[17] Trans-abdominal ultrasound imaging is a non-invasive method to measure the PFM function, and bladder base displacement can be used to represent activity of PFM contraction.[18] While there are some factors that may affect the assessment (i.e., no body landmark), high correlation with perineometry and acceptable reliability has been showed in previous studies.[19,20]

Data extraction and synthesis

The data extraction process followed a systematic and standardized approach to ensure accuracy and consistency. Two independent reviewers screened and extracted data using a pre-designed form. The data extracted included authors, publication year, country, study design, sample size, participant characteristics (age, parity, delivery method), the details of intervention and control groups (mode, frequency, duration), and the reported outcomes of each study.

Risk of bias and certainty of evidence

Study quality was evaluated using the Cochrane Risk of Bias 2.0 tool across key domains, including randomization, intervention deviations, missing data, measurement, and reporting. Two independent reviewers conducted the assessments, with disagreements resolved by a third reviewer. The certainty of evidence was rated using the GRADE approach, considering risk of bias, inconsistency, indirectness, imprecision, and publication bias.[21] Downgrading decisions based on outcome measures were applied when measurements were subjective, lacked assessor blinding (risk of bias), did not directly reflect clinically meaningful endpoints (indirectness), or demonstrated high variability and wide confidence intervals (CI) (imprecision, assessed using the minimally contextualized approach[22]).

Statistical analysis

Data synthesis integrated narrative and quantitative methods, using Review Manager 5.3 for statistical analysis. When only medians and interquartile ranges were reported in original article, means and standard deviations were estimated using translation formulas.[23] Missing data were retrieved from figures using GetData Graph Digitizer or by contacting study authors. Standardized mean differences (SMDs) with 95 % CIs were calculated, as outcomes were measured using various validated instruments.[24] Meta-analyses were performed using a random-effects model for all outcomes to account for anticipated clinical and methodological heterogeneity across studies.[25] Statistical significance was set at P value <0.05. The Funnel plots and Egger's tests were used to assess publication bias.

Sensitivity analyses were performed by study design, excluding the quasi-randomized trial to assess the robustness of the findings. Stratified subgroup analyses or meta-regression analyses were performed for outcomes with substantial heterogeneity ($I^2 > 50$ %) to explore potential sources of variability. Where data permitted, subgroup analyses focused on baseline pain severity (mild vs. moderate/severe), intervention mode (supervised vs. unsupervised), and control type (general exercise vs. passive care). Meta-regression was performed using mean age of participants, baseline pain severity, duration of intervention, and total

sessions of intervention as moderators. When subgroup data were insufficient or inconsistent, a qualitative synthesis was conducted instead of quantitative pooling.

Results

Study selection

A total of 499 studies were screened in the initial search stage through seven electronic databases. After removing duplicate articles and screening titles and abstracts for eligibility, 15 studies were included in the final review. The detailed review process is illustrated in the PRISMA flow diagram (Fig. 1).

Study characteristics

Among the included studies, 14 were RCTs and 1 was a quasi-randomized trial,[26] published between 2000 and 2024. Thirteen were

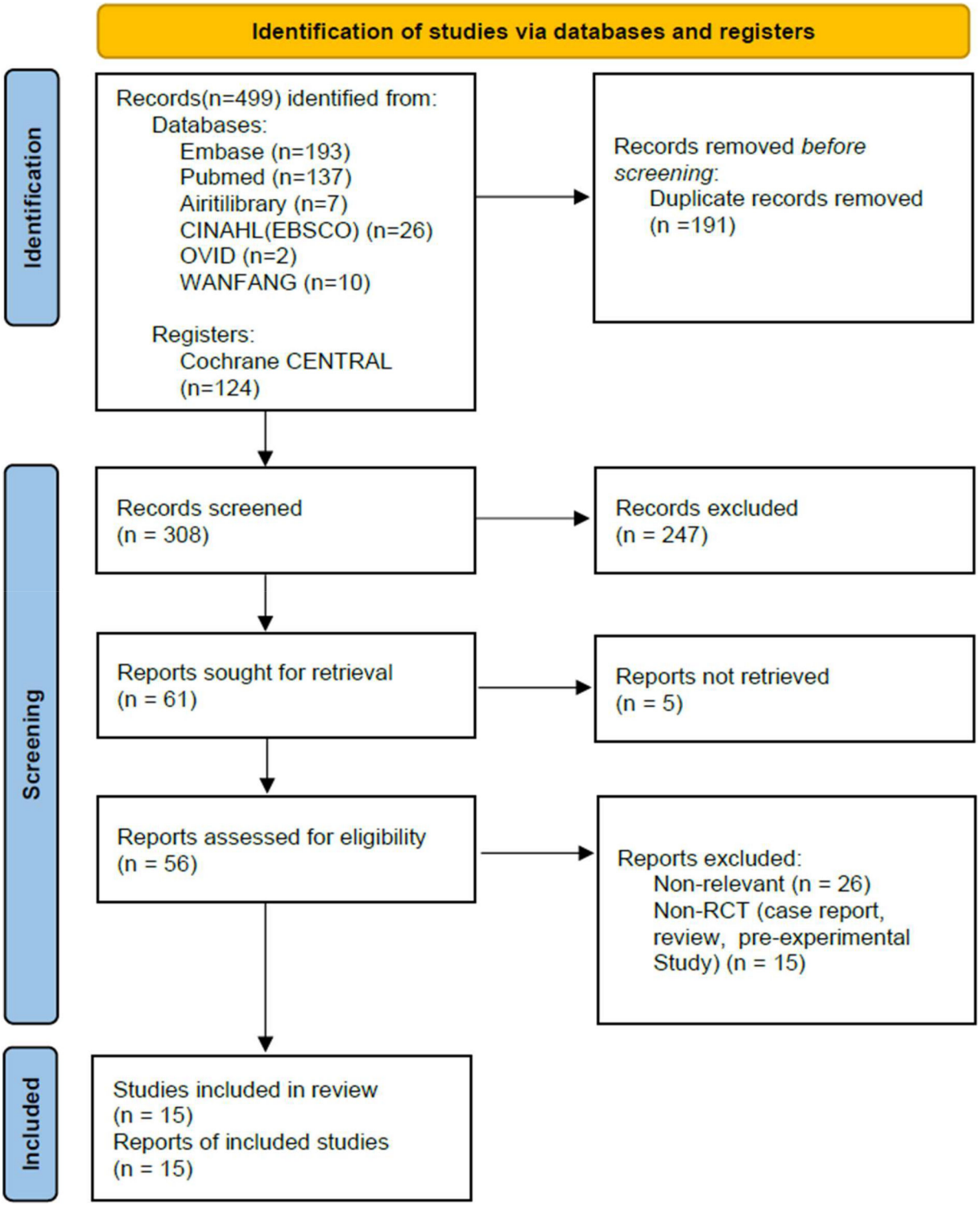

Fig. 1. PRISMA flow diagram.

written in English and two in Chinese. The trials were conducted across various regions: China ($n = 2$) ,[27,28] Taiwan ($n = 2$) ,[26,29] Pakistan ($n = 3$),[30–32] Iran ($n = 4$)[33–36] Egypt ($n = 1$),[37] Sweden ($n = 1$),[38] Norway ($n = 1$)[39] and the Netherlands ($n = 1$)[40] The mean age of participants ranged from 28.4 to 36.8 years, and the LPP severity at baseline was mild in 4 studies,[26,27,29,38] moderate in 9 studies[28,30,32,34–37,39,40] and severe in 1 study.[33] One study did not report pain at baseline.[31] Detailed study and participants characteristics are in Table 1.

The core stabilizing exercise focused on lumbopelvic stabilization and core strengthening, targeting muscles such as the TrA, PFM, and multifidus. Formats included supervised sessions[28,30–34,36,37] biofeedback-assisted training,[27,29] and home-based programs with video[26,35,38–40] The control groups consisted of general exercise,[30–32,34,36,39] passive interventions such as electrotherapy (i.e., infrared irradiation, ultrasound, neuromuscular electrical stimulation), manual therapy (i.e., massage, joint mobilization), and education-only programs,[26–28,33,37,38] or no intervention.[29,35,40] The durations of intervention ranged from 4 to 20 weeks, the frequencies of 2 to 7 sessions per week, with a total session from 12 to 60. The lengths of each session ranged from 10 to 60 min, with a low-to-moderate exercise intensity tailored by a physical therapist.

Publication bias in included studies

Publication bias was assessed using Egger's test and visual inspection of funnel plots. The funnel plots for pain and disability were symmetrical. Egger's test for pain ($t = -4.95$, $p = 0.174$), disability ($t = -0.94$, $p = 0.372$), and QoL ($t = 1.42$, $p = 0.384$) showed no significant bias. The funnel plots are presented in Supplementary Appendix B.

Risk of bias in included studies

Details of the assessment of risk of bias of included studies are presented in Fig. 2.

Among the included studies, only one was rated as low risk across all domains.[29] Most studies were judged as having "some concerns," primarily due to limitations in the randomization process (Domain 1) and outcome measurement (Domain 4), such as insufficient details on allocation concealment or lack of assessor blinding. Two studies were rated as high risk overall.[26,28] In contrast, Domains 2 (deviations from intended interventions), 3 (missing outcome data), and 5 (selection of the reported result) were generally rated as low risk across studies. These findings indicated a moderate overall risk of bias, with methodological weaknesses concentrated in early-phase or poorly reported trials.

Outcome measures

The results of pain, disability and QoL are presented in Fig. 3, and the detailed GRADE judgments are summarized in Table 2. The summary of GRADE traffic light is presented in Supplementary Appendix B. Detailed sensitivity analyses, subgroup analyses, and meta-regression analyses are provided in the Supplementary Appendix C.

Pain

Fourteen studies reported the change of pain intensity as an outcome measure, using the Visual Analogue Scale (VAS)[28,33–35,37–40] Numerical Rating Scale (NRS)[27,29,30,32,36] and pain severity items of Brief Pain Inventory (BPI-C).[26] The pooled results using the random-effects model indicated that the core stabilizing exercise significantly reduced the pain when compared with the control group (SMD = −0.80, 95 % CI: −1.15 to −0.46; $p < 0.00001$), with high heterogeneity ($I^2 = 79$ %, $p < 0.00001$). Sensitivity analysis showed consistent findings after exclusion of the quasi-randomized trial. Subgroup analyses suggest that control type, and baseline pain severity may contribute to the observed heterogeneity, with acceptable heterogeneity observed in subgroups with passive care ($I^2 = 44$ %) and mild pain ($I^2 = 0$ %). The subgroup analyses showed that core stabilizing exercise consistently produced significant pain reduction over both general exercise and passive care. Both supervised and unsupervised formats demonstrated superior effects than control group. Because the direction and magnitude of effects were consistent, no downgrading for inconsistency was applied; overall evidence was rated as moderate certainty (GRADE), downgraded for imprecision (Table 2).

Disability

Twelve studies reported the change of functional disability as outcome measurement, using the Oswestry Disability Index (ODI)[28,30–33,35,37–39] modified ODI[27,36] and the Pelvic Girdle Questionnaire (PGQ).[29] The pooled results using the random-effects model indicated that the core stabilizing exercise significantly improved the disability when compared with the control group (SMD = −0.85, 95 % CI: −1.17 to −0.54; $p < 0.00001$). High heterogeneity was present ($I^2 = 71$ %, $p < 0.0001$). Subgroup analyses suggest that baseline pain severity, and intervention mode may contribute to the observed heterogeneity, with acceptable heterogeneity observed in subgroup with unsupervised intervention ($I^2 = 0$ %) and mild pain ($I^2 = 26$ %). The subgroup analyses showed that core stabilizing exercise consistently produced significant disability improvement over both general exercise and passive care. Both supervised and unsupervised formats demonstrated superior effects than control group. Effect estimates were consistent, so no downgrading for inconsistency was warranted; overall evidence was rated as high certainty according to GRADE (Table 2).

Quality of life

Five studies reported the change of QoL as outcome measure, using the SF-36[27,39], Nottingham Health Profile (NHP) ,[40] EuroQoL instrument,[38] and BPI-C.[26] The subscales related to physical functioning were extracted. The pooled results using the random-effects model indicated that the core stabilizing exercise significantly improved the QoL when compared with the control group (SMD = 0.44, 95 % CI: 0.06 to 0.82; $p = 0.02$). Moderate heterogeneity was present ($I^2 = 63$ %, $p = 0.03$). Given the limited number of studies and the inability of subgroup analyses to identify sources of heterogeneity. Sensitivity analysis excluding the quasi-randomized trial attenuated the effect to a non-significant level (SMD = 0.35, 95 % CI: −0.09 to 0.80; $p = 0.12$). The certainty rated as low (GRADE) due to imprecision and unexplained heterogeneity (Table 2).

Core muscle contractibility

Three studies assessed the core muscle contractibility.[29,33,34] Due to considerable heterogeneity in outcome measurement methods across studies, a narrative synthesis was presented instead of meta-analysis. All studies used ultrasound to assess PFM strength via bladder base displacement. Two reported significant improvements,[33,34] while one showed no significant change but a trend favoring the intervention.[29] Transversus abdominis muscle thickness was evaluated in two studies,[29,34] and the changes in muscle thickness during specific movement tasks were measured via ultrasound. The results were inconsistent, though one study demonstrated improvement after the intervention.[34]

Discussion

The study reviewed and synthesized the evidence for the effect of core stabilizing exercise in postpartum women with LPP. The meta-analysis showed that core stabilizing exercise was effective on pain reduction, functional disability, and QoL in this population, and it may be potentially beneficial for the core muscle contractibility. The

Table 1
Summary of the included studies.

Author, year	Country	Sample size		Age	Pain severity (mm)	Intervention duration and frequency		Intervention group	Control group	Outcome measurement
		IG	CG			Duration (weeks)	Frequency (session/wk)			
Mens et al., 2000[40]	Netherlands	16	14	IG: 30.7 ± 3.7 CG: 32.1 ± 2.2	Moderate IG: 57.6 ± 10.8 CG: 60.3 ± 19.6	8	3	Videotape Diagonal trunk muscle exercises	Refrained from any exercises	Pain: VAS QoL: NHP
Stuge et al., 2004[39]	Norway	40	41	IG: 32.4 ± 4.0 CG: 32.3 ± 3.8	Moderate IG: 52.0 ± 22.0 CG: 60.0 ± 28.0	20	3	Home-based, with individual adjustment by the PT once a week or every second week Physical therapy with specific stabilizing exercises	Physical therapy include stretching, and strengthening exercises without specific stabilizing exercises	Pain: VAS Disability: ODI QoL: SF-36
Gutke et al., 2010[38]	Sweden	26	39	IG: 32.0 ± 4.0 CG: 30.0 ± 4.0	Mild IG: 19.0 ± 3.5 CG: 16.0 ± 4.3	N/A	7	Home-based, with individual adjustment by the PT every second week Specific stabilizing exercises focused on the TrA, PFM and the lumbar multifidus	Education	Pain: VAS Disability: ODI QoL: EQ-5D
Teymuri et al., 2018[33]	Iran	18	18	IG: 33.6 ± 6.9 CG: 36.8 ± 9.2	Severe IG: 74.4 ± 18.5 CG: 82.8 ± 17.1	6	3	Supervised by an experienced PT specific stabilizing exercises with electrotherapy	Electrotherapy agents (i.e. TENS), and hot pack	Pain: VAS Disability: ODI
Yuan et al., 2018[26]	Taiwan	25	28	IG: 30.6 ± 3.4 CG: 31.3 ± 3.2	Mild IG: 31.0 ± 21.9 CG: 22.1 ± 17.3	6	3	Videotape core stabilizing exercise with birth ball	Education	Pain: BPI-C QoL: BPI-C
Saleh et al., 2019[37]	Egypt	17	17	IG: 29.9 ± 3.0 CG: 29.5 ± 2.6	Moderate IG: 61.8 ± 12.9 CG: 59.4 ± 11.4	6	3	Supervised by PT Core stabilizing exercises with traditional treatment	Traditional treatment (i.e. infrared irradiation, ultrasound)	Pain: VAS Disability: ODI
Ehsani et al., 2019[34]	Iran	35	33	IG: 29.9 ± 3.0 CG: 29.5 ± 2.6	Moderate IG: 67.4 ± 16.3 CG: 59.1 ± 18.0	8	3	Supervised Stabilizing exercise focused on TrA and PFM muscle activity	General exercise	Pain: VAS
Khorasani et al., 2020[35]	Iran	28	27	IG: 30.3 ± 5.7 CG: 30.8 ± 5.1	Moderate IG: 66.0 ± 23.7 CG: 64.4 ± 23.5	12	3	Home-based with videotape co-activation of the TrA and pelvic floor muscle while maintaining the corresponding positions	No intervention	Pain: VAS Disability: ODI
Ouyang et al., 2020[28]	China	51	49	IG: 29.7 ± 3.6 CG: 29.6 ± 3.5	Moderate IG: 70.2 ± 11.4 CG: 70.2 ± 11.5	4	3	Supervised Specific stabilizing exercise focused on TrA and multifidus muscle	Massage	Pain: VAS Disability: ODI
Adnan et al., 2021[30]	Pakistan	13	14	IG: 28.4 ± 4.8 CG: 29.6 ± 3.3	Moderate IG: 60.0 ± 11.5 CG: 60.0 ± 23.1	8	3	Supervised static core exercise with hot pack	General exercise with swiss ball	Pain: NRS Disability: ODI
Saleem et al., 2021[31]	Pakistan	20	20	IG: 29.8 ± 4.1 CG: 30.2 ± 4.3	N/A	6	3	Supervised Abdominal crunches training with general exercises	Double straight leg raise exercises with general exercises	Disability: ODI
Wang et al., 2021[27]	China	48	48	IG: 29.0 ± 1.6 CG: 28.4 ± 4.1	Mild IG: 46.0 ± 3.0 CG: 45.0 ± 3.0	12	1~4	Supervised A stabilization strengthening program with NMES and with biofeedback-assisted PFMT	Only NMES	Pain: NRS Disability: modified ODI QoL: SF-36
Ghavipanje et al., 2022[36]	Iran	20	20	IG: 29.3 ± 4.1 CG: 29.4 ± 3.5	Moderate IG: 63.5 ± 10.3 CG: 65.5 ± 10.5	6	6	3 supervised sessions, and 3 home-based sessions Dynamic Neuromuscular Stabilization approach	General exercise without importance on the activation of the TrA	Pain: NRS Disability: modified ODI

(*continued on next page*)

Table 1 (*continued*)

Author, year	Country	Sample size		Age	Pain severity (mm)	Intervention duration and frequency		Intervention group	Control group	Outcome measurement
		IG	CG			Duration (weeks)	Frequency (session/wk)			
Chaudhry et al., 2023[32]	Pakistan	14	14	N/A	Moderate IG: 59.3 ± 2.7 CG: 60.0 ± 0.2	8	3	Supervised Trunk stabilization exercises included isometric back, gluteus exercise, bridging, abdominal bracing, SLR exercises	Trunk activation exercises included abdominis muscles, and erator spinae exercises	Pain: NRS Disability: ODI
Kuo et al., 2024[29]	Taiwan	18	17	IG: 35.0 ± 4.0 CG: 35.0 ± 4.0	Mild IG: 44.0 ± 17.0 CG: 48.0 ± 20.0	8	3	Supervised Core stabilizing exercise with biofeedback PFMT	Usual activities without exercise	Pain: NRS Disability: PGQ

IG: intervention group; CG: control group; mm: millimeter; session/wk: session per week; VAS: Visual Analogue Scale; QoL: quality of life; NHP: Nottingham Health Profile; PT: physical therapist; ODI: Oswestry Disability Index; SF-36: 36-item short-form; N/A: Not applicable; EQ-5D: EuroQol Five Dimensions Questionnaire; BPI-C: Brief Pain Inventory-Chinese version; TrA: transversus abdominis muscle; PFM: pelvic floor muscle; NRS: Numerical Rating Scale; NMES: Neuromuscular Electrical Stimulation; PFMT: pelvic floor muscle training; PGQ: Pelvic Girdle Questionnaire.

inclusion of a quasi-randomized trial may enhance the comprehensiveness of evidence base as it provided data on the limited outcome QoL and was among the few studies published in Chinese.[26] The potential risk of bias of quasi-randomized design was clearly reported, and sensitivity analysis was performed accordingly. The overall quality of evidence was low to high in the primary outcome measurement, with a moderate risk of bias among included trials.

The results of the systematic review supported the previous review that core stabilizing exercise was beneficial for postpartum LPP.[12] Furthermore, the inclusion of more sample size in the updated analysis may have increased statistical power, potentially revealing a significant effect of QoL that was not previously detected. Core stabilizing exercise may improve QoL by reducing pain, which in turn helps restore physical function and decreases limitations in daily activities.[26] The reduction of pain may also improve sleep, mood, and emotional well-being, thereby enhancing overall QoL.[26,41] Importantly, the significant findings were not robust as sensitivity analysis showed loss of significance when excluding the quasi-randomized trial. Future studies with rigorously designed RCTs are needed to confirm these findings.

The study showed that core stabilizing exercise effectively alleviated pain and disability in postpartum women with LPP, which was consistent with previous studies.[12,42] According to the World Health Organization, pain and disability are closely intertwined—unaddressed pain can lead to movement avoidance, and physical deconditioning, all of which perpetuate functional decline.[43] Postpartum instability caused by pregnancy-related overstretching may be mitigated through core stabilizing exercises, which enhance stability, proprioception, and reduce muscle overactivity.[12,44] Furthermore, core stabilizing exercise may enhance central pain modulation through improved body awareness and sensorimotor reintegration, leading to the analgesic effects and functional improvement as observed in chronic low back pain population.[45] Given the established link between pain and functional disability, alleviating pain likely enables greater physical participation and reduces activity limitations.

Despite the high heterogeneity in pain and disability outcomes, greater inconsistency was observed among participants with moderate to severe pain, possibly reflecting differences in underlying pain mechanisms. Individuals with mild symptoms may present more consistent musculoskeletal patterns and respond more uniformly to intervention, whereas those with greater pain may exhibit central sensitization, altered motor control, and psychological comorbidities.[46,47] The multifactorial influences may affect the outcome of stabilizing exercise. Future study could investigate the association of higher pain severity and related psychosocial factors with the treatment outcomes.

A positive trend of core muscle contractility was observed in postpartum women with LPP who receiving core stabilizing exercise. However, due to the limited number and the considerable heterogeneity in measurement methods, data could not be pooled for quantitative analysis and affect the confident of conclusion. For example, the thickness of TrA was measured during different tasks (i.e., low-load task, active straight leg raise) in two studies,[29,34] highlighting the lack of consistency in assessment protocols. Furthermore, the absence of gold standard for PFM function assessment may have contributed to the variability in outcomes.[48] Future studies with standardized measurement protocols for assessing core muscle contractility are needed to enhance comparability across studies.

Variability in intervention protocols may have influenced outcomes, such as frequency, duration, intensity, and level of supervision. For example, while both supervised and unsupervised core stabilizing exercise were effective on pain reduction, the supervised programs showed greater pain reduction, possibly due to enhanced adherence and movement accuracy cues provided by physical therapists. Although intervention duration varied from 4 to 20 weeks across included studies, improvements in postpartum LPP were observed. The benefits of short-duration intervention were also demonstrated in a previous study with a 4-week training, and the improvements may be attributed to enhanced proprioception, balance, and reduced fear of movement through core stabilizing exercise.[49]

Clinical implications

According to the American College of Obstetricians and Gynecologists, physical activity and exercise is safe and encouraged for postpartum women once medically cleared.[50] The superior effect of core stabilizing exercise over general exercise found in the subgroup analyses suggested that it may be a more effective recommendation for this population. In addition, the effectiveness across both supervised and unsupervised formats highlights its feasibility in diverse settings. These findings align with international postpartum guidelines[50,51] and support the core stabilizing exercise as a recommended clinical intervention for postpartum LPP.

The overall certainty of evidence ranged from high to low across outcomes. Downgrading was primarily due to imprecision, with wide CIs around the clinical importance threshold and the loss of robustness showed in sensitivity analysis, and due to unexplained heterogeneity related to limited sample sizes. Although the observed effects consistently favored the intervention, some results remain uncertain as the clinical importance is not fully established. Future studies with larger sample sizes, adequate power, and standardized designs are needed to strengthen the evidence base.

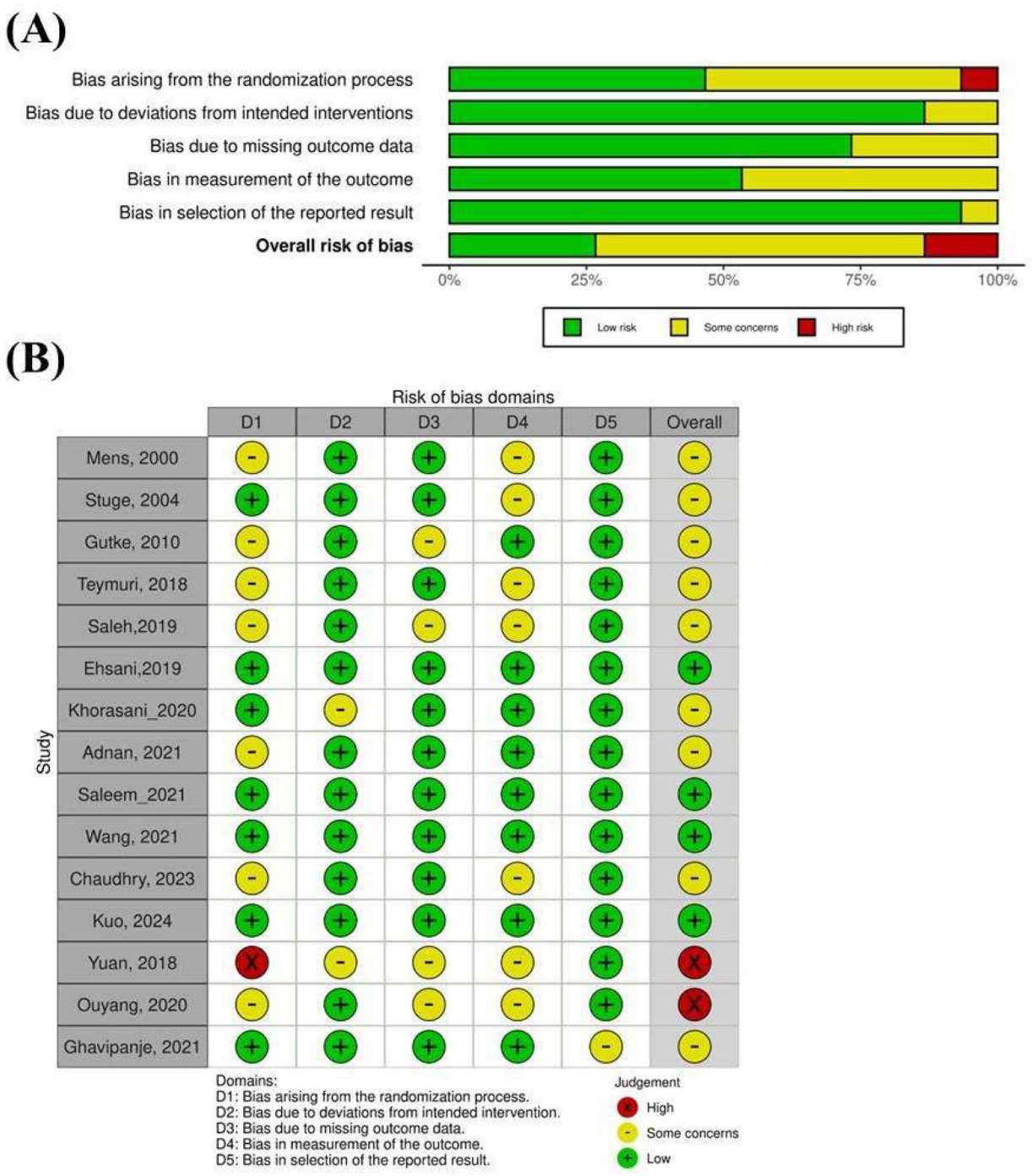

Fig. 2. (A) Risk of bias graph and (B) summary of review authors' judgements on each risk of bias item for the included studies.

Limitations

There are several limitations that should be considered in the study. First, the considerably varied parameters of intervention across included studies may have influenced the treatment effects and limit the ability to determine the optimal dosage. Future studies could perform dose-response analyses to provide clear guidance for clinical recommendations. Second, the risk of bias assessment indicated a moderate overall risk, mostly due to the infeasibility of blinding participants and therapists in exercise interventions, which may lead to performance bias. In addition, language and publication bias may exist due to the restriction to English and Chinese publications, limitation of data database sources, and the exclusion of gray literature. These factors may affect the generalizability of our findings. Lastly, the long-term effects remain inconclusive as only three of the included studies conducted the follow-up assessments after the intervention period. Postpartum LPP is closely related to reduced QoL and has potential to develop into chronic pain if not properly managed.[52] Therefore, further research should incorporate extended follow-up periods to explore the durability of treatment effects over time.

Conclusions

The meta-analysis demonstrated that core stabilizing exercise effectively improved pain, disability, and QoL in postpartum women with LPP, with high-to-moderate certainty for pain and disability, and

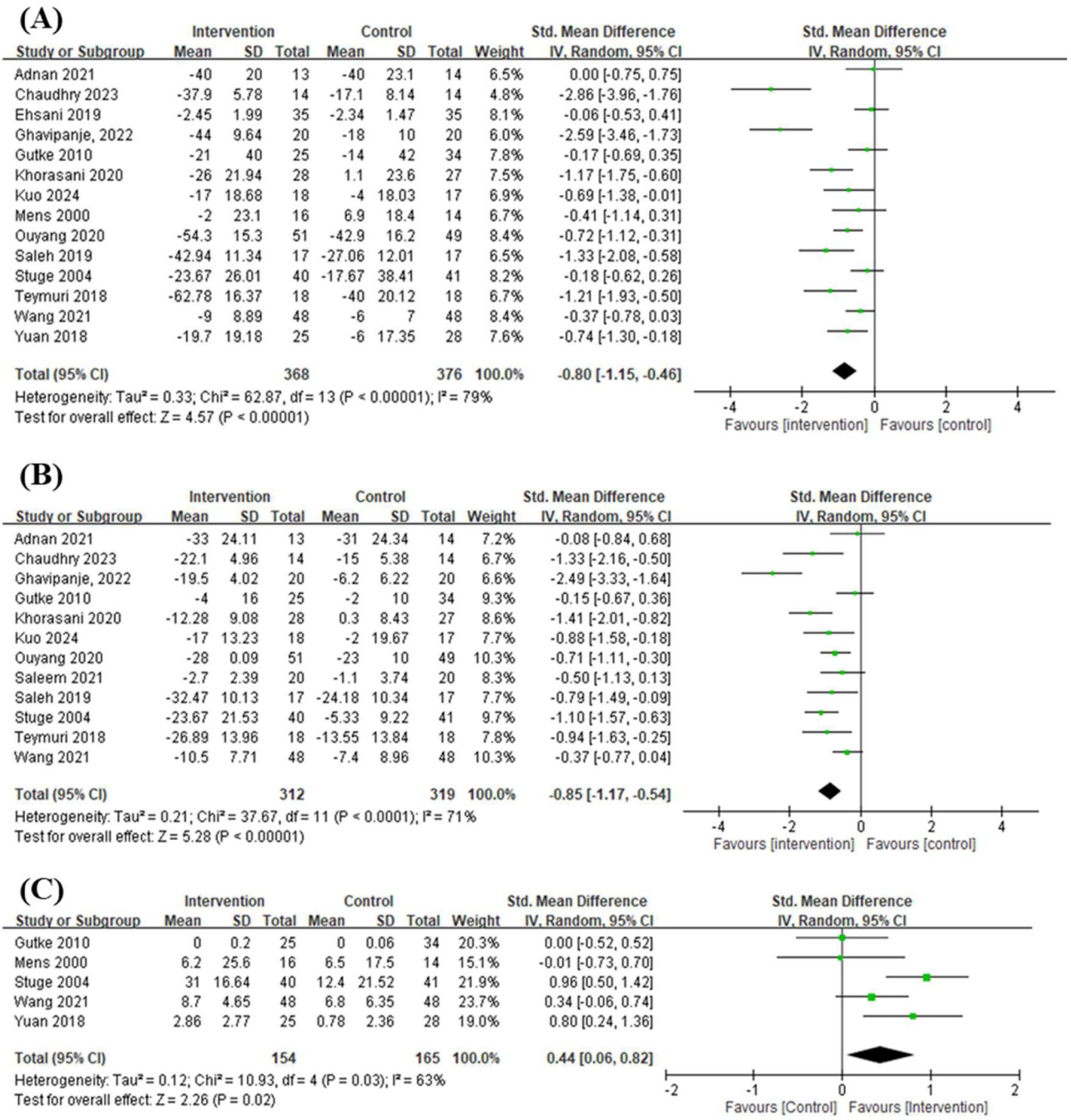

Fig. 3. Forest plot of the effect of stabilization exercise versus control on (A) pain, (B) disability, and (C) quality of life.

low certainty for QoL. Both supervised and unsupervised core stabilizing exercise may be superior to general exercise and passive care for this population. A positive trend in core muscle contractibility was observed, and future studies with standardized measurement methods are needed to confirm these findings.

Author contributions

Yu-Tsen Yin: study design, acquisition of data, analysis and interpretation of data, drafting the manuscript, and approval of the final version to be submitted.

Kuan-Yin Lin: study design, interpretation of data, revising the article critically for important intellectual content, and approval of the final version to be submitted.

Chen-Yu Chen: conceptualization, project administration, and approval of the final version to be submitted.

Chien-Nan Yeh: project administration, and approval of the final version to be submitted.

Yi-Ting Li: study design, acquisition of data, analysis and interpretation of data, drafting the manuscript, and approval of the final version to be submitted.

Systematic review registration

The systematic review was registered at PROSPERO (CRD42025631791).

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Table 2
A summary of the GRADE assessment.

Outcome	Number of participants	Effect Estimate (95 % CI)	Crosses clinical important threshold (Cohen's $d = 0.5$) [a]	OIS consideration [b]	GRADE Rating	Comments
Pain	743 (13 RCTs and 1 quasi-randomized trial)	SMD −0.80 (−1.15, −0.46)	Yes (upper bound −0.46 > −0.5; CI crosses threshold)	93 % of OIS (slightly below OIS), but CI crossing threshold takes precedence	Moderate ⊕⊕⊕⊖	Risk of bias: No downgrading. Although two high-risk studies were included,[26,28] they accounted for small proportion (16.0 %) of the sample, with effects consistent with the overall trend.@@@@Inconsistency: No downgrading. Although moderate heterogeneity (I^2 = 79 %), subgroup analyses explained variability, and the direction of effect was consistent. @@@@Imprecision: Downgraded one level as the CI overlapped with the clinical important threshold. @@@@Publication bias: No downgrading. No significant asymmetry was found in Egger's test.
Disability	631 (12 RCTs)	SMD −0.85 (−1.17, −0.54)	No (The CI does not overlap with the threshold)	79 % of OIS (slightly below OIS), the CI does not overlap with the threshold	High ⊕⊕⊕⊕	Risk of bias: No downgrading. Only one high-risk study included,[28] with small sample proportion (10.3 %) of the total sample.@@@@Inconsistency: No downgrading. Despite heterogeneity (I^2 = 71 %), effect estimates were consistent across studies and subgroups. @@@@Imprecision: No downgrading as the CI did not cross the clinical important threshold, and the sample size was close to OIS (79 %).@@@@Publication bias: No downgrading. No significant asymmetry was found in Egger's test.
Quality of life	319 (4 RCTs and 1 quasi-randomized trial)	SMD 0.44 (0.06, 0.82)	Yes (lower bound 0.06 < 0.5; CI crosses threshold)	40 % of OIS (far below OIS), but CI crossing threshold takes precedence	Low ⊕⊕⊖⊖	Risk of bias: No downgrading. Only one high-risk study included,[26] with small sample proportion (19.0 %) of the total sample.@@@@Inconsistency: Downgraded one level due to unexplained heterogeneity (I^2 = 63 %) and limited number of studies.@@@@Imprecision: Downgraded one level as the CI crossed the clinical important threshold, and the significant effect was lost in the sensitivity analysis excluding the quasi-randomized trial.@@@@Publication bias: No downgrading. No significant asymmetry was found in Egger's test.

CI: confidence interval; **OIS**: optimal information size; **SMD:** standardized mean difference; **RCT:** randomized controlled trial.
GRADE Working Group certainty of evidence:.
High quality (⊕⊕⊕⊕): Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality (⊕⊕⊕⊖): Further research is likely to have an important impact on our confidence in the estimate and may change the estimate.
Low quality (⊕⊕⊖⊖): Further research is very likely to have an important impact on our confidence in the estimate and is likely to change the estimate.
Very low quality (⊕⊖⊖⊖): We are very uncertain about the estimate.
Imprecision assessment (based on a minimally contextualized approach[22]).
Step 1: Confidence interval (CI).
If the 95 % CI crossed the threshold (i.e., included both trivial and clinically important effects), we downgraded for imprecision.
If the 95 % CI did not cross the threshold (entirely within the clinically important range), no downgrade was applied at this step.
Step 2: Optimal information size (OIS).
When the CI did not cross the threshold, we further assessed sample size.
For continuous outcomes, we used a rule-of-thumb OIS of ~800 participants.
≥100 % OIS (≥800): no downgrade.
~70–90 % OIS (~560–720): "slightly below OIS," generally no downgrade but noted.
~50–70 % OIS (~400–560): "moderately below OIS," considered downgrading 1 level.
~30–50 % OIS (~240–400): "clearly below OIS," downgraded 1–2 levels.
<30 % OIS (<240): "far below OIS," usually downgraded ≥2 levels.
[a] : Threshold for clinical importance: We prespecified Cohen's $d = 0.5$ as the cutoff for a clinically important effect (moderate effect size).
[b] : Classification of sample size relative to OIS:.

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Declaration of competing interest

The authors declare no competing interest.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.bjpt.2026.101597.

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