

The Effect of Pelvic Floor Muscle Training Along with an Exercise Intervention in Non-specific Chronic Low Back Pain: A Systematic Review and Meta-analysis of Randomized Controlled Trials

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ABSTRACT

Introduction: Non-specific chronic Low back pain (NSCLBP) is often linked to trunk muscle dysfunction, affecting abdominopelvic stability. Research emphasizes assessing pelvic floor muscle (PFM) strength in women with NSCLBP, and therefore, PFM training could serve as a valuable component to enhance rehabilitation by improving pain, strength, and functionality.

Objective: The present systematic review and meta-analysis aim to synthesize and evaluate the findings from randomized clinical trials (RCTs) that investigate the impact of pelvic floor muscle-strengthening exercises on pain, functional disability, muscle strength, and quality of life.

Data sources: Electronic searches were conducted across databases such as Scopus, Web of Science, CINAHL, Cochrane Central, PEDro, PubMed, ProQuest, and MEDLINE to identify relevant RCTs published up to July 2023.

Study eligibility criteria: Eligible studies compared PFM training with exercise interventions for individuals with NSCLBP, and potential biases were assessed using the RoB 2 tool.

Study appraisal and synthesis method: For the synthesis of results, MedCalc software version 23.0.9 was used, and a random-effects model was applied to address heterogeneity.

Results: The review included eight RCTs focused on individuals with NSCLBP. The review findings indicate that PFM training is effective in reducing pain intensity on the Visual Analog Scale (VAS: SMD = -0.644, 95% CI = -0.953 to -0.335). The meta-analysis showed neutral to favorable results for function, pelvic floor strength, transversus abdominis strength, and quality of life.

Conclusion: Synthesizing data from multiple RCTs, this review highlights the efficacy of pelvic floor muscle-strengthening interventions in reducing NSCLBP. However, the shorter duration of most studies may limit insights into long-term effects, as extended programs are needed for muscle adaptation, improved motor control, and enhanced lumbar-pelvic stabilization.

Keywords: Exercise, Low back pain, Meta-analysis, Pelvic floor muscle, Systematic review.

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INTRODUCTION

Low back pain (LBP) is a common musculoskeletal problem, influencing the lumbar spine, and demographics show that 90% of people experience it at least once in their lifetime.¹

LBP presents itself in distinct phases: acute, subacute, and chronic. Acute LBP manifests with pain lasting up to six weeks. Subacute LBP extends from six to twelve weeks. Chronic LBP persists beyond twelve weeks, becoming a persistent challenge affecting daily life and mobility.²

Only 10% of LBP cases have a clearly identifiable cause. In most instances, the underlying pathoanatomical factors—such as disc herniation, infection, tumors, or osteoporotic fractures—remain unclear, resulting in a diagnosis of non-specific LBP (NSLBP).³

Women are affected out of proportion by non-specific chronic Low back pain (NSCLBP), due to a non-neutral trunk posture, commonly adopted by women during daily activities, increasing the risk of developing LBP.⁴ Additionally, obesity is identified as a significant risk factor contributing to the development of NSCLBP.²

The abdominal cavity functions as an anatomical unit where intra-abdominal pressure is evenly distributed in all directions. This pressure is regulated by the coordinated actions of the pelvic floor,

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spinal muscles, abdominal muscles, and diaphragm. A synergistic and coordinated response among these muscles is essential for controlling vital functions such as continence, respiration, gastrointestinal function, and spinal stability.

Optimal neuromuscular strategies for maintaining these functions have been extensively studied. In healthy individuals, the pelvic floor and transverse abdominal muscles work synergistically to increase intra-abdominal pressure, contributing to spinal stiffness. However, any biomechanical disruption in the structures regulating intra-abdominal pressure can lead to dysfunctions such as lumbopelvic pain or incontinence.⁵

A wide range of studies have examined the impact of various treatment modalities, highlighting that exercise-based therapies can result in long-lasting improvements in pain and functional ability. As a result, clinical guidelines for managing NSCLBP in primary care emphasize the importance of exercise interventions to alleviate pain and improve strength and mobility. These may include specific activities like coordination, stabilization, and strength training, as well as broader approaches such as yoga, Pilates, or aquatic therapy programs.

Exercise programs have been found to effectively alleviate pain in individuals with NSCLBP, although the impact is often moderate. One possible explanation for this limited effect is that traditional exercise routines may not fully engage all the muscle groups involved in maintaining spinal motor control, which are frequently influenced by LBP.

There is growing recognition of the importance of pelvic floor muscles (PFMs) in managing lumbar spine stability; however, they are often excluded from exercise programs for NSCLBP. Pelvic floor muscle activation helps elevate intra-abdominal pressure and engages the transversus abdominis, supporting spinal control.⁶

Currently, many physical therapists treat women with LBP using models focused on spine muscle control and coordination, often overlooking pelvic floor disorders (PFD). This narrow approach can lead to suboptimal management for both patients and therapists, particularly if treatment outcomes are unsatisfactory.

Burcin Ugur Tosun et al. suggest in their study that PFM weakness may play a significant role in the onset of LBP. This, in turn, can contribute to disability and ultimately result in a decline in quality of life.³

However, it remains unclear whether incorporating PFM exercises into existing exercise interventions offers additional benefits for treating NSCLBP. An exercise intervention refers to any program that uses exercise as a modality to manage and alleviate LBP.

Numerous interventional studies across diverse populations worldwide have investigated the effect of pelvic floor muscle-strengthening exercises on alleviating NSCLBP. While these studies demonstrate benefits such as reducing self-reported pain severity

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Conflict of interest: None

and improving functional disability, very few have addressed their impact on enhancing muscle strength, and almost no research has focused on improving quality of life; hence, further exploration is needed to determine whether incorporating pelvic floor muscle training (PFMT) into existing exercise programs offers additional advantages compared to programs without PFMT.

Thus, this review aims to compile and analyze the findings from randomized controlled trials (RCTs) on the effectiveness of pelvic floor muscle-strengthening exercises in conjunction with other exercises for alleviating NSCLBP.

OBJECTIVE

The present systematic review and meta-analysis aim to synthesize and evaluate the findings from RCTs that investigate the impact of pelvic floor muscle-strengthening exercises on pain, functional disability, muscle strength, and quality of life.

METHODS

Eligibility Criteria

The PICOS (Table 1) framework helped identify keywords related to the population, intervention, comparison, outcomes, and study design, thereby refining the database searches. This approach ensured that relevant studies were accurately targeted in the literature search.

Exclusion Criteria

The exclusion criteria included the irrelevant studies, cross-sectional studies, case reports, case series, case studies, letter to the editor, qualitative studies, dissertations, systematic review and meta-analysis, clinical practice guidelines, animal studies, duplicate studies, lack of access to the full text of the articles, lack of sufficient data, and lack of control group.

Information Sources

The protocol of this systematic review adheres to the 2020 recommendations of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Statement (PRISMA) and is registered in the PROSPERO 2023 database (registration number: CRD42023451095). A comprehensive literature search was conducted across several electronic databases, including Scopus, Web of Science, CINAHL, Cochrane Central, PEDro, PubMed, ProQuest, and MEDLINE (Ovid), from date of inception to July 2023. Since this study involved only an analysis of existing, published data, ethics approval was not required.

Table 1: Eligibility criteria based on PICOS

<i>PICOS framework tool</i>	<i>Inclusion criteria</i>
P – Population	Women with non-specific chronic Low back pain aged 18 years and above would be included
I – intervention	Pelvic floor muscle training in addition to an exercise intervention
C – Comparison	Standard care or any exercise intervention
O – Outcome	Pain, muscle strength, physical function/disability, or quality of life
S – Study Design	Randomized controlled trials

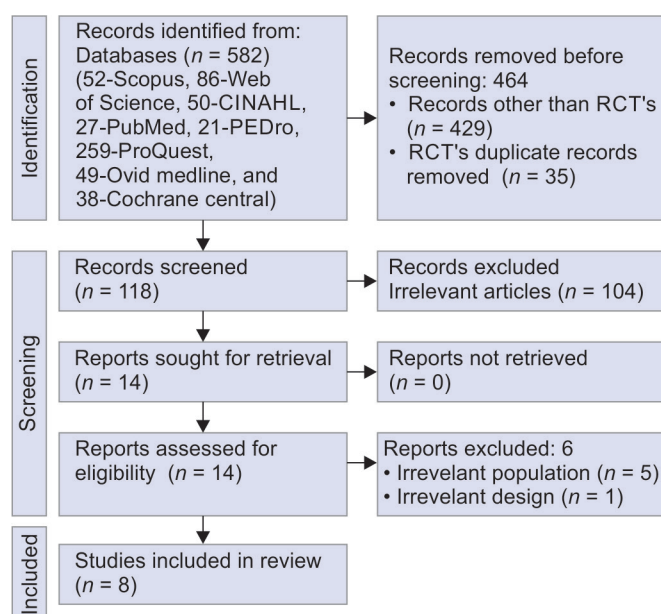


Fig. 1: PRISMA flow diagram – Studies selection process in the systematic review

Search Strategy

Two authors separately reviewed the titles and abstracts of the studies found and independently evaluated trials that were potentially eligible for inclusion. Any disagreements between the authors were settled through discussion and mutual agreement, with a third author consulted if necessary.

Non-specific chronic Low back pain is defined as pain not linked to specific anatomical or physiological causes, such as disc herniation, nerve root issues, or severe conditions like rheumatoid diseases or metastases. Studies were considered regardless of whether exercise was the sole treatment or part of a combined approach. For this review, pelvic floor muscle training (PFMT) is defined as exercises aimed at enhancing the strength, endurance, power, relaxation, or a mix of these aspects of the pelvic floor muscles, based on Bo et al.⁶

The searches included the combinations of the following MeSH terms for PubMed: "Pelvic floor or pelvic diaphragm or pelvic floor disorder" and "Low back pain or back pain or chronic back pain or mechanical back pain or lumbago or lower back pain" and Keywords: "Pelvic muscle or PFM or Kegel or pelvic floor therapy or pelvic floor physiotherapy" and "LBP or chronic LBP or lower back pain."

Study Selection

The database search identified 582 articles, with 153 RCTs. After removing 35 duplicates, 118 articles were screened, and 104 were excluded. Of the 14 assessed for eligibility, eight were included. The PRISMA flow diagram (Fig. 1) outlines the process, and study characteristics are detailed in Table 2.

Data Extraction

Two independent reviewers, (MT and SK), extracted data from the selected studies into a standardized Microsoft Excel (Version 2406) form. This form included (a) bibliographic information (authors,

year of publication), (b) study details (study design, sample size, sample description, country, follow-up duration), (c) participant characteristics (gender, age, duration of symptoms, type of LBP), (d) description of the interventions (both experimental and control), including dosage (number of sessions, duration, supervision, adherence, etc.) and co-interventions, (e) follow-up assessment duration, (f) outcomes assessed, and (g) study results (means, standard deviations, and sample sizes). Table 3 depicts a summary of each of the pelvic floor and other exercise intervention programs.

Risk of Bias Assessment

The assessment of risk of bias (RoB) was conducted using the RoB 2 tool for individually randomized trials, as recommended by The Cochrane Collaboration.⁷ The risk of bias 2 (RoB 2) tool is an updated version of the original RoB tool introduced in 2008.

Two independent reviewers (MT and SK) carried out the RoB assessment, and any disagreements were resolved through discussion or arbitration by a third reviewer (AA) if consensus was not reached. The RoB for each domain was categorized as "low risk," "high risk," or "unclear risk" based on the criteria outlined in the RoB assessment tool.

The RoB assessments for individual studies are summarized in Figure 2. Three studies—Fariba Ghaderi et al., Giordani G et al., and MA Mohseni-Bandpei et al.—were rated as having an unclear risk of selection bias due to insufficient information provided about the intended interventions. One study, Bhatnagar et al., was deemed to have a high RoB related to the measurement of outcomes. Four studies—Abdel-Aziem et al., Bi et al., Fahime Khorasani et al., and Shamima Islam Nipa et al.—were assessed as having a low RoB.

Data Synthesis

A comprehensive search of electronic databases yielded 582 articles, with 14 selected for detailed review and eight ultimately meeting the inclusion criteria (Fig. 1).

Exclusions were based on factors such as irrelevant titles, unsuitable methodologies, lack of control groups, observational or pilot studies, review articles, insufficient data analysis, or publication in non-English languages. Studies were included if they provided exercise interventions, adhering to or deviating from standard pelvic floor training guidelines, specifically targeting individuals with NSLBP.

RESULTS

Meta-analysis was performed only when at least two studies aligned regarding population, intervention, comparison, outcomes (PICO), and study design. For the synthesis of results, MedCalc software version 23.0.9 was used, and a random-effects model was applied to address heterogeneity.

Mean differences (MDs) were calculated to pool continuous variables, employing the inverse variance method and 95% confidence intervals (95% CIs). The consistency of results was assessed using the I^2 statistic and interpreted according to the guidelines by Higgins et al.⁸ No dichotomous variables were identified.

When required, standard errors were converted to standard deviations. No instances of multiple reports from a single study were encountered. Results were presented using forest plots for outcomes included in the meta-analysis, and funnel plots are provided in the APPENDIX for reference.

Table 2: Characteristics of included studies, participants, and outcomes

Sl. No.	Author, Year	Design	Country	Sample size	Gender (Male:Female) ^a	Age (years) ^b	BMI ^b	Type of LBP	Duration of Intervention	Outcomes measured	
										• Self-reported pain severity	• PFM and any other muscle strength
1.	Amr A. Abdel-Aziem et al., (2021) ⁹	RCT (single-blind)	Egypt	48 (E = 24, C = 24)	E = 0:24 C = 0:24	E = 36.71 (6.17) C = 38.14 (5.89)	E = 22.74 (1.59) C = 22.42 (1.39)	Chronic Non-specific LBP	6 weeks	• NPRS	• ODI
2.	Bhatnagar et al., (2017) ¹⁰	RCT (single-blind)	India	30 (E = 15, C = 15)	Both genders included but ratio is unclear	E = 41.46 (8.61) C = 38.86 (8.79)	Not mentioned	Chronic Non-specific LBP	6 weeks	• NPRS	• ODI
3.	Bi et al., (2014) ¹¹	RCT (double-blind)	China	50 (E = 25, C = 25)	E = 13:10 C = 13:11	E = 29.08 (2.68) C = 30.87 (2.81)	E = 21.01 (2.03) C = 22.13 (2.58)	Chronic Non-specific LBP	24 weeks	• VAS	• ODI
4.	Fahime Khorasani et al., (2020) ¹²	RCT (two-arm, single-blind, parallel trial)	Iran	80 (E = 40, C = 40)	E = 0:40 C = 0:40	E = 30.75 (5.09) C = 30.25 (5.65)	Not mentioned	Chronic Postnatal non-specific LBP + SUI	12 weeks	• VAS	• Modified Oxford Grading scale for PFM strength
5.	Fariba Ghaderi et al., (2016) ¹³	RCT	Iran	60 (E = 30, C = 30)	E = 0:30 C = 0:30	E = 53.2 (1.1) C = 52.6 (1.06)	E = 26.6 (0.7) C = 27.5 (0.8)	Chronic Non-specific LBP + SUI	12 weeks	• VAS	• Modified Oxford Grading scale
6.	Giordani, G et al., (2022) ¹⁴	RCT (a two-arm, single-blind trial)	Italy	26 (E = 13, C = 13)	E = 0:13 C = 0:13	E = 49.6 (11.3) C = 58.5 (9.6)	Not mentioned	Chronic Non-specific LBP + SUI	5 weeks	• VAS	• Modified Oxford Grading scale
7.	M.A. Mohseni-Bandpei et al., (2011) ¹⁵	RCT	Iran	20 (E = 10, C = 10)	E = 0:10 C = 0:10	E = 34.71 (5.03) C = 34.91 (6.29)	E = 23.89 (2.48) C = 24.05 (2.27)	Chronic Non-specific LBP	12 weeks	• VAS	• Perineometer for PFM strength
8.	Shamima Islam Nipa et al., (2022) ¹⁶	RCT (stratified)	Bangladesh, Thailand	50 (E = 25, C = 25)	E = 0:25 C = 0:25	E = 41.00 (9.07) C = 40.84 (8.82)	E = 28.90 (6.81) C = 27.20 (6.02)	Chronic Non-specific LBP + SUI	12 weeks	• VAS	• PBU

C, Control; E, Experimental; ICIQ-SF UI, International Consultation on Incontinence Questionnaire-Short Form; ISI, incontinence severity index; LBP/A, Low back pain/ache; NPRS/NPRS, Numerical pain or rating scale; ODI, Oswestry disability index; PBU, Pressure biofeedback unit; QoL-KHQ, Quality of life—King's Health Questionnaire; Tra strength, Transverse abdominis strength; UI, Urinary Incontinence; VAS, Visual analog scale (0–10); a, reported in number; b, reported as mean (standard deviation)

Table 3: Intervention protocols of the included studies

Intervention details													
PFMT protocol													
PFM													
	Type of PFM exercise	Contraction verified through palpation	Position of patient	PFM exercise Separate or combined with other exercise	Group or individual training	Weekly frequency	Supervised or unsupervised	Frequency of PFMT	PFM education	Home program	Adherence and compliance	Other exercise	Electrotherapy modalities
1.	Amir A. Abdel-Aziem et al., (2021) ⁹	Strength training	Not mentioned	Lying	Separate	Not mentioned	3 times/ week for 6 weeks	Supervised by PT	6 sec contraction of the PFM followed by 6 sec rest, resulting in 5 contraction cycles/min. A) 1st week (25 cycles/d, 5 min total); B) 2nd week (50 cycles/d, 10 min total); C) 3rd week (75 cycles/d, 15 min total); D) 4th to 6th weeks (100 cycles/d, 20 min total)	Not mentioned	Recommended	Stabilization exercise, 20 repetitions with 15 sec hold. The whole exercise set was repeated twice with 3 min rest in between. 3 times/week	A) IRR B) Conventional TENS C) Ultrasound Therapy
2.	Bhatnagar et al., (2017) ¹⁰	Strength training	Not mentioned	Lying	Separate	Not mentioned	Weekly frequency not mentioned, 6 weeks are intervention duration	Not mentioned	6 sec contraction of the PFM followed by 6 sec rest, resulting in 5 contraction cycles/min. A) 1st week (25 cycles/d, 5 min total); B) 2nd week (50 cycles/d, 10 min total); C) 3rd week (75 cycles/d, 15 min total); D) 4th to 6th weeks (100 cycles/d, 20 min total)	Not mentioned	Not mentioned	Lumbar strengthening exercises	A) Ultrasound Therapy B) Short-wave diathermy
(Contd...)													

(Contd...)

Table 3: (Contd...)

Intervention details									
PFMT protocol									
Sl. No.	Studies	PFM		PFM exercise		PFMT		Adherence and compliance	
		Type of PFM exercise	Contraction verified during exercise	Position of patient	Separate or combined with other exercise	Group or individual training	Weekly frequency	Supervised or unsupervised	Frequency of PFMT
3.	Bi et al., (2014) ¹¹	Strength training	Not mentioned	Not mentioned	Separate	Not mentioned	Weekly frequency not mentioned, 24 weeks is intervention duration	Supervised by PT	6 sec contraction of the PFM followed by 6 sec rest, resulting in 5 contraction cycles/min. A] 1st week (25 cycles/d, 5 min total); B] 2nd week (50 cycles/d, 10 min total); C] 3rd week (75 cycles/d, 15 min total); D] 4th to 24th weeks (100 cycles/d, 20 min total)
4.	Fahime Khorasani et al., (2020) ¹²	Strength training	Yes, only during 1st session	Lying Sitting Quadruped Standing	Combined with stabilization exercise	Not mentioned	3 days/ week, 3 sets/day, 12 weeks	Unsupervised	Performed co-activation of the TrA and PFM while maintaining the corresponding positions. Each set had 10 reps of 3 different types of exercise each week. Each contraction involved 8–10 sec hold time and the same rest time
5.	Fariba Ghaderi et al., (2016) ¹³	Strength training at 30% of maximal voluntary contraction	Not mentioned	Lying Sitting Quadruped Standing	Combined with stabilization exercise	Not mentioned	3 days a week, 3 sets a day, and 10 repetitions, 12 weeks	Supervised by PT	Performed co-activation of the abdominal muscles and PFM while maintaining the corresponding positions. All exercises were separated by a 2-min rest interval.
									Yes, only during 1st session. Leaflet and video CD was provided
									Only Homebased exercise program
									Not measured as its home based exercise program. Exercises were monitored weekly through phone calls by the physiotherapist.
									Stabilization exercise, 3 days/week, 3 sets/day, 12 weeks
									Not mentioned
									A] TENS, B] Hot pack, C] Therapeutic ultrasound
									A] Strengthening and endurance exercises for the abdominal and para-vertebral muscles for control group. B] Progressive stabilization exercises for the deep

(Contd...)

Table 3: (Contd...)

Intervention details															
PFMT protocol															
Sl. No.	Studies	Type of PFM exercise	PFM Contraction during exercise verified through palpation	Position of patient	PFMT exercise Separate or combined with other exercise	Group or individual training	Weekly frequency	Supervised or unsupervised	Frequency of PFMT	PFMT education	Home program	Adherence and compliance	Other exercise	Electrotherapy modalities	
6.	Giordani, G et al., ¹⁴ (2022)	Strength training	Not mentioned	Not mentioned	Separate	Not mentioned	10 sessions, 2 times/ week, 5 weeks.	Supervised by PT	1st exercise, a slow contraction for 5 sec and a slow relaxation for 5 sec of the perineal muscles. Rest time was 20 sec. The 2nd exercise required a slow contraction for 5 sec, holding of the contraction for 5 sec and a slow relaxation for 5 sec. Rest time was 30 sec	Not mentioned	Not mentioned	Not mentioned	Each 60 min session consisted of 20 min of PFM rehabilitation and 40 min of postural rehabilitation or spinal mobilization, based on the allocation group.	Not mentioned	
7.	M.A. Mohseni-Bandpei et al., ¹⁵ (2011)	Strength training	Not mentioned	Crook-lying	Separate	Not mentioned	6 times/ day, 12 weeks	Not mentioned	4 contractions lasting for 5 s with 4 s rest between each contraction. Progress up to 10 contractions lasting for 10 s.	Not mentioned	Not mentioned	Not mentioned	Back flexor and extensor strengthening exercises	A) Transcutaneous electrical nerve stimulation B) Infra-red C) Therapeutic ultrasound	
8.	Shamima Islam Nipa et al., ¹⁶ (2022)	Strength training	Not mentioned	Supine, sitting, kneeling, and standing positions	Separate	Not mentioned	Performed one set of exercises during each week intervention, 12 weeks	Supervised by PT	8–12 times, progressed to 20 contractions, 3 times a day. Holding went from 4 sec to 30–40 sec.	Patients of both groups were told the benefits of the intervention and instructed on how to do the exercise at the beginning	Home exercise – 20 repetitions, two times a day	Telephone calls, feasible appointments, and counseling of family member were conducted	Core exercises, 10 to 20 times on each leg, 2 to 3 sets with 30 to 60 sec of rest between each set of exercises.	Not mentioned	

PFM, pelvic floor muscle; PFMT, pelvic floor muscle training; TrA, transversus abdominis

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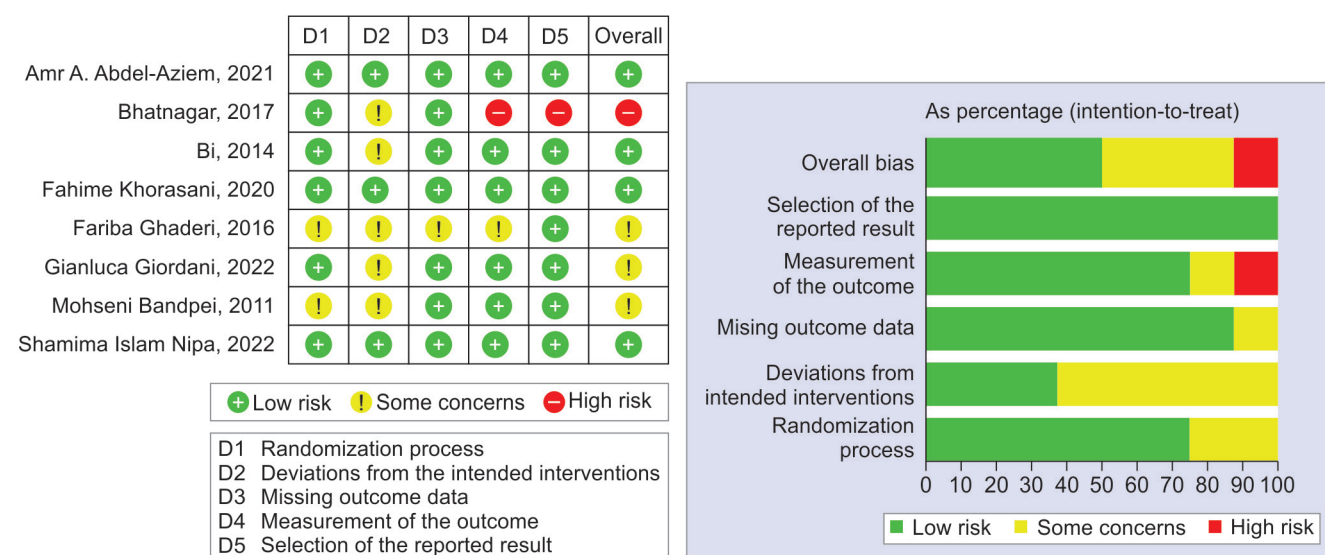


Fig. 2: Summary of risk of bias assessment

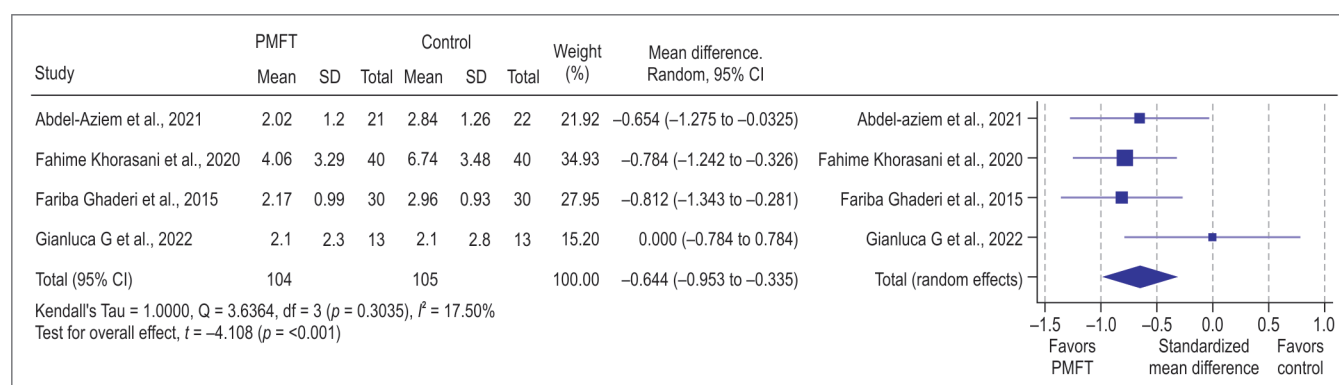


Fig. 3: Forest plot displays the effect of interventions on outcome measure pain

The primary outcomes of this review were on self-reported pain levels and evaluation of pelvic floor and other muscle strength. Secondary outcomes included disability and quality of life.

Pain and functional disability were consistently measured across most studies to evaluate the impact of PFMT combined with additional exercises for non-specific chronic LBP. Few studies assessed the strength of the pelvic floor and the transversus abdominis muscles. While no study exclusively addressed quality of life in relation to LBP, those involving participants with urinary incontinence utilized questionnaires specific to incontinence-related quality of life.

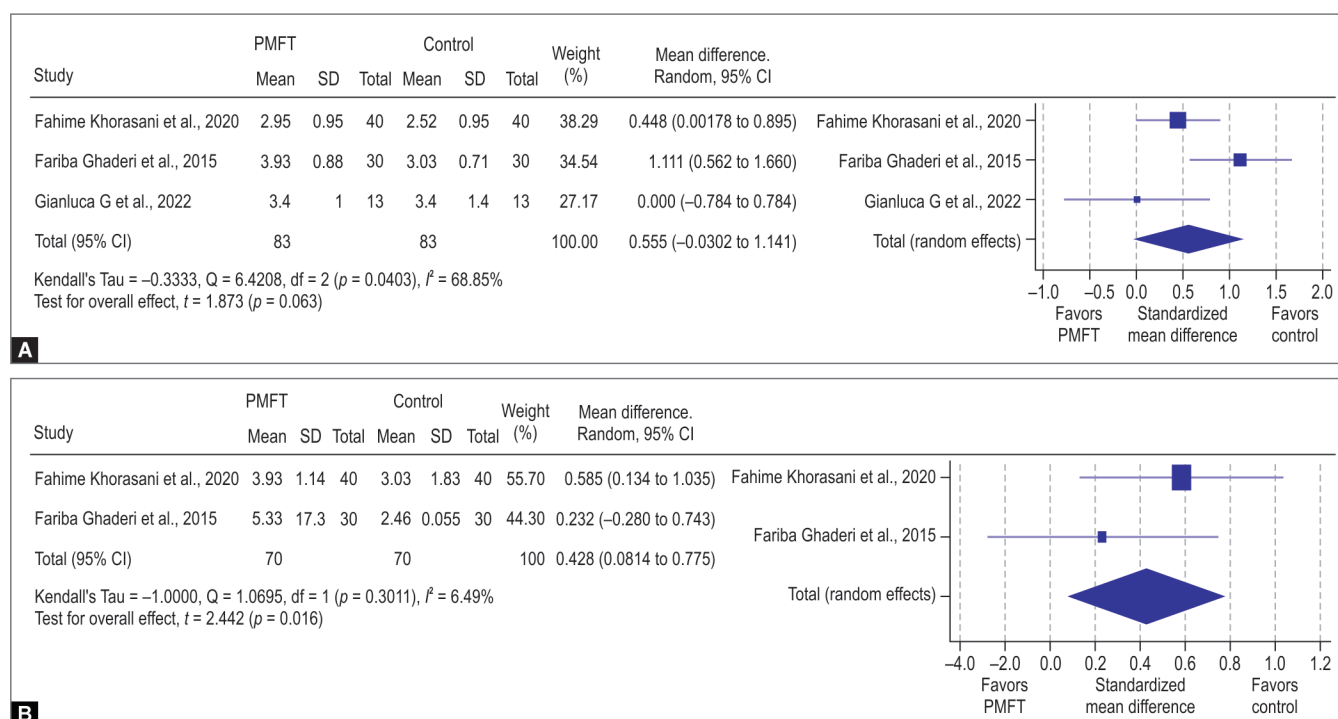
Two RCTs were excluded from the meta-analysis because they included both male and female participants, and the data could not be separated by gender.^{10,11} Additionally, data values were unavailable for two studies.^{15,16} Consequently, the meta-analysis was conducted using only four studies. The reviewer reached out to the corresponding author via email to request the unavailable data. A funnel plot was created; however, given the limited number of studies included in the meta-analysis, the detection of publication bias is unlikely. The funnel plots are available for reference in APPENDIX.

Primary Outcome Measure: Pain

Four studies were analyzed for pain.^{9,12–14} A total of 209 participants out of which 104 participants were in the exercise program group and 105 participants in the control group, were taken for analysis. Heterogeneity (I^2) was 17.50%. The mean difference was -0.644 (95% CI: -0.953 to 0.335) for the exercise program compared to the control group (Fig. 3).

Primary Outcome Measure: Muscle Strength

- Three studies with a total of 166 participants (83 in the exercise group and 83 in the control group) were analyzed for PFM strength.^{12–14} The heterogeneity (I^2) was 68.85%. The exercise program showed a mean difference of 0.555 (95% CI: -0.0302 to 1.141) compared to the control group (Fig. 4A).
- Two studies were analyzed for transversus abdominis (TrA) strength, involving 140 participants (70 in the exercise group and 70 in the control group).^{12,13} Heterogeneity (I^2) was 6.49%. The exercise program demonstrated a mean difference of 0.428 (95% CI: -0.0814 to 0.775) compared to the control group (Fig. 4B).



Figs 4A and B: (A) Forest plot displays the effect of interventions on Outcome measure PFM Strength; (B) Forest plot displays the effect of interventions on Outcome measure TrA Strength

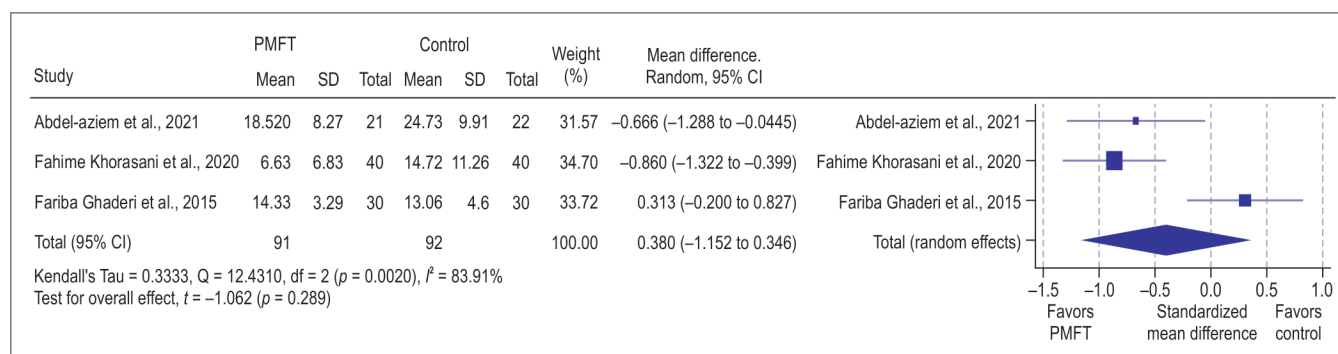


Fig. 5: Forest plot displays the effect of interventions on Outcome measure Functional Disability

Secondary Outcome Measure: Functional Disability

Three studies were analyzed for functional disability, including 183 participants (91 in the exercise group and 92 in the control group).^{9,12,13} Heterogeneity (I^2) was 83.91%. The exercise program showed a mean difference of -0.380 (95% CI: -1.152 to 0.346) compared to the control group (Fig. 5).

Secondary Outcome Measure: Quality of Life

Three studies were analyzed for quality of life.¹²⁻¹⁴ A total of 166 participants out of which 83 participants were in the exercise program group and 83 participants in the control group, were taken for analysis. Heterogeneity (I^2) was 91.08%. The mean difference was -0.495 (95% CI: -1.617 to 0.626) for the exercise program compared to the control group (Fig. 6).

DISCUSSION

Chronic LBP poses a global public health challenge, affecting muscle strength, physical function, and overall quality of life. This systematic review evaluates the effectiveness of PFM training in improving clinical outcomes for individuals with chronic LBP. Eight RCTs were analyzed, revealing that PFM exercises significantly reduced LBP compared to control groups. The meta-analysis incorporated studies assessing LBP alone or in conjunction with parameters such as muscle strength, disability, and quality of life.

Out of eight studies, six exclusively involved females with chronic non-specific LBP, four of whom also had urinary incontinence.^{12-14,16} While participants were not pregnant in any of the studies, one study focused on postpartum women with persistent LBP.¹² Details on pain characteristics or treatment history

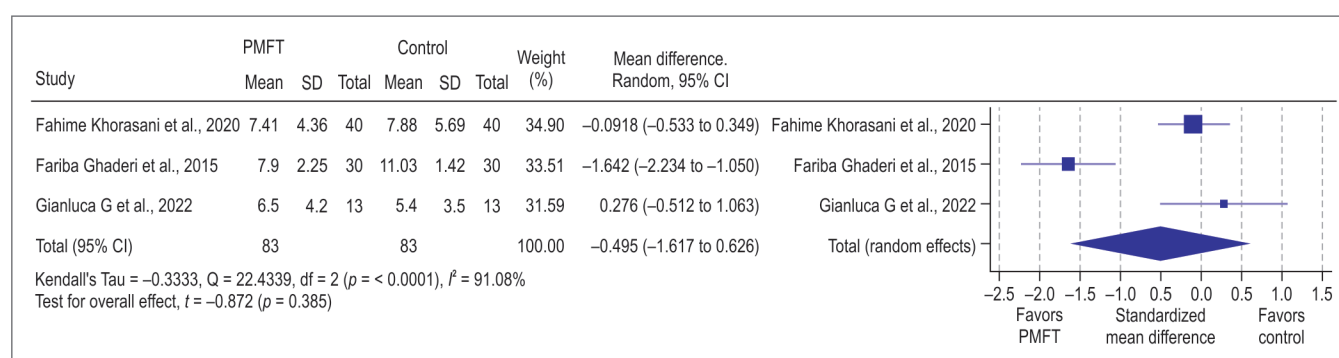


Fig 6: Forest plot displays the effect of interventions on Outcome measure Quality of life

were largely absent, and only one study included a long-term follow-up.¹¹

Only two studies incorporated PFM exercises and stabilization exercises simultaneously, rather than treating them as separate components.^{12,13} Five studies confirmed that exercises were supervised by a health professional, while three reported providing PFM education prior to the intervention.^{9,11,13,14,16} Two studies encouraged participants' adherence to the exercise program, and only one verified PFM contraction through palpation.^{12,16} Except for three studies, all others included co-interventions, such as electrophysical agents, in both treatment groups.^{9,11,13,15}

Regarding PFM treatment positions, three studies used the lying position exclusively, three utilized multiple positions, including lying, sitting, quadruped, and standing while two studies did not specify the treatment position.⁹⁻¹⁵

None of the studies specified whether PFM training was conducted as one-on-one or group sessions. Details regarding the weekly frequency and progression of PFM training were unclear across a few studies.

Adherence to the training programs was not formally measured in any of the studies; however, studies mentioned follow-up strategies such as telephone calls and counseling sessions for family members to encourage participation (see Intervention characteristics, Table 3).^{12,16}

Low back pain has been shown to disrupt motor control of key stabilizing muscles, including the lumbar multifidus and TrA. Additionally, LBP may act as a trigger for diminished tonic PFM support, contributing to conditions such as pelvic organ prolapse, urinary frequency, stress urinary incontinence (SUI), urgency, and urge incontinence.¹⁶

Principal Findings

For the primary outcome of pain intensity, pretest pain levels were comparable across groups, ensuring valid comparisons. All four trials showed significant post-intervention pain reduction, with two focusing on isolated pelvic floor contractions and two on deep trunk muscle synergies.^{9,12-14} Both conventional and pelvic floor training treatments reduced pain, but the experimental group achieved greater improvement (mean = 2.587 vs 3.66). These findings underscore the importance of best practices in managing chronic non-specific LBP.

The PFMT program's impact on muscle strength of the pelvic floor and TrA was inconclusive. While the forest plot favored the control group, the experimental group showed greater

improvements (PFM strength mean = 3.42 vs 2.9; TrA Strength mean = 4.63 vs 2.74). Only three studies assessed pelvic floor strength, and two evaluated TrA strength, with one, noting the program's short duration as insufficient for meaningful muscle-strengthening.¹²⁻¹⁴ Lack of adherence reporting further limited the evaluation of PFMT effectiveness.

Regarding functional disability, the trials showed significant and clinically relevant improvements in functional disability with pelvic floor exercises.^{9,12} Both intervention types reduced disability, with greater improvement in the experimental group (mean = 21.835 vs 32.09). However, one study reported no improvement in the PFMT group.¹³

Quality of life was not directly assessed for LBP in any study but was evaluated using incontinence-specific questionnaires in studies with associated urinary incontinence in NSCLBP.¹²⁻¹⁴ The experimental group showed greater improvement (mean = 7.27) compared to the control group (mean = 8.09). Post-intervention, two trials reported significant improvements in quality of life, while the third showed improvements in both groups.¹²⁻¹⁴

The pelvic floor (PF) operates as a musculoskeletal unit with passive, neural, and active subsystems. Fascia and ligaments form the passive subsystem, while sensory feedback drives neural control, which can be disrupted post-vaginal delivery. The active subsystem ensures continence, organ stability, and lumbo-pelvic support and regulation of intra-abdominal pressure (IAP). Pelvic floor muscles, along with the TrA, diaphragm, and lumbar multifidus, stabilize the trunk during rapid movements. Low back pain can impair motor control in these muscles, reducing PFM support and causing dysfunctions like bladder control issues.¹⁷

Current evidence supports pelvic floor muscle training (PFMT) for managing NSLBP but highlights gaps in optimizing protocols. Effective PFMT requires patient education, proper identification of inefficient contractions, professional supervision, structured exercises, and a minimum 12-week duration for meaningful outcomes in pain relief and quality of life. Many studies lack consistency in these parameters, leading to varied results.

Women, more affected by chronic LBP, report poorer quality of life than men, emphasizing their greater burden.² Standardizing and refining PFMT protocols are essential to enhance therapeutic outcomes.

Future studies should include larger samples, as most trials reviewed had fewer than 60 participants, limiting statistical power and generalizability. Randomized controlled trials must also assess long-term outcomes to evaluate broader impacts. Motivation

and adherence are key to successful exercise programs. Given the variability in interventions and small outcome differences, the effectiveness of PFM training for NSCLBP remains uncertain. While there is a promising trend, further research is needed to identify the most effective exercises and strengthen the evidence.

Strengths and Limitations

This systematic review and meta-analysis have notable strengths, including adherence to a registered protocol, the inclusion of RCTs, and the use of validated measures like pain severity, muscle strength, physical function, and quality of life.

However, limitations include the inability to perform subgroup analyses, significant heterogeneity due to varying intervention parameters, small sample sizes, and some studies with a RoB.

CONCLUSION

This review highlights that incorporating PFMT into exercise programs reduces pain severity in NSCLBP, with modest gains in muscle strength, function, and quality of life. Shorter study durations limit observations of long-term benefits, as extended programs allow for better muscle adaptation and stabilization. Despite limited studies, PFMT is a valuable, low-risk component of lumbopelvic exercise programs for managing non-specific LBP.

Practical Implications

- Regular PFM training has been shown to decrease self-reported pain severity in individuals with NSCLBP by addressing biomechanical imbalances and improving neuromuscular control.
- Strengthened PFMs contribute to better movement patterns, improving functional mobility, making daily activities easier and less painful for individuals with NSCLBP.
- Adding PFMT to existing rehabilitation protocols can ensure a more comprehensive approach by targeting often-neglected pelvic floor muscles, which play a crucial role in core stability.

AUTHOR CONTRIBUTION

- MT, AA, and SK contributed to the study idea and participated in most of the study steps.
- MT and SK performed the literature review.
- NK and SB assisted with the study design.
- MT, SK, and AA performed risk of bias assessment and drafted the manuscript.
- YR. performed the statistical analysis.
- MT, AA, and NK contributed to the interpretation of the findings.
- All authors reviewed and approved the final manuscript.

Data Availability

The author declares that data supporting the findings of this study are available

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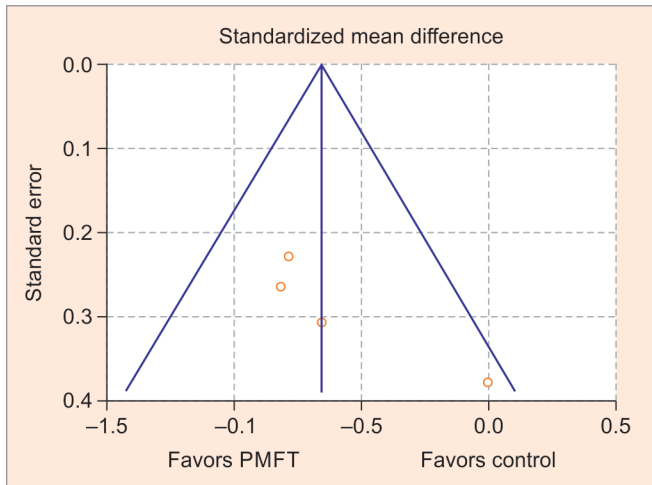
AI Usage

During the preparation of this work, the author(s) used ChatGPT to enhance the clarity and coherence of the content while ensuring the scientific integrity of the work remains uncompromised. After using this tool, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the published article.

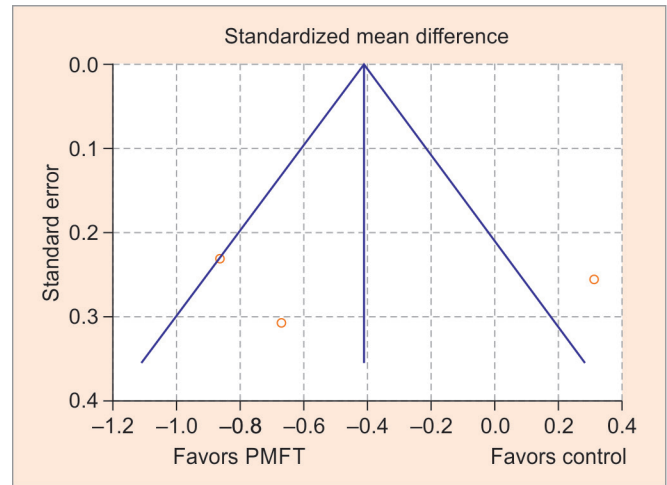
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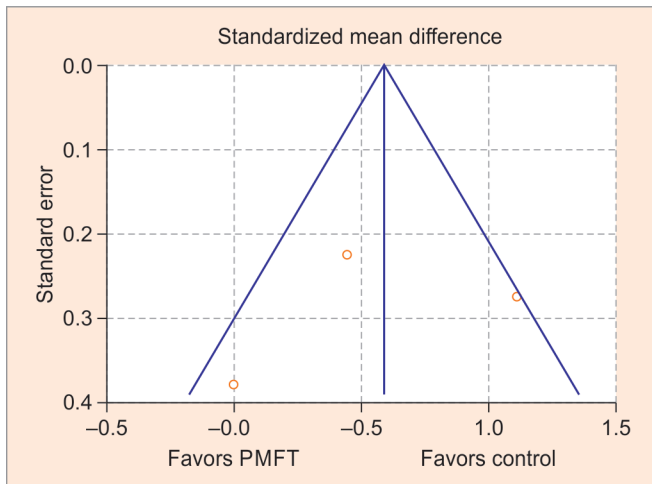
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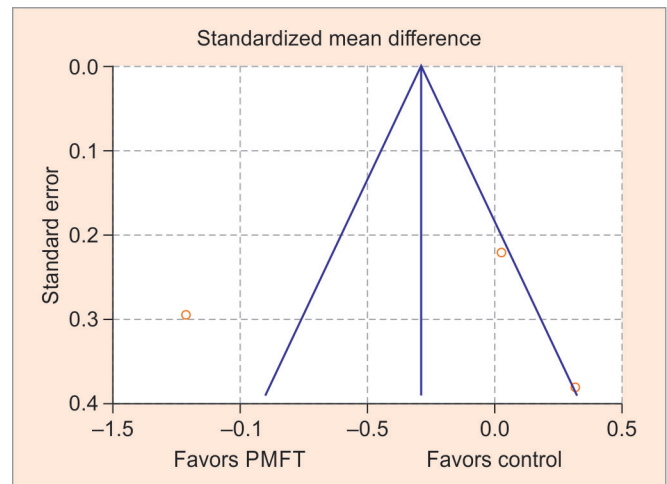
A.1: Funnel Plot – Pain



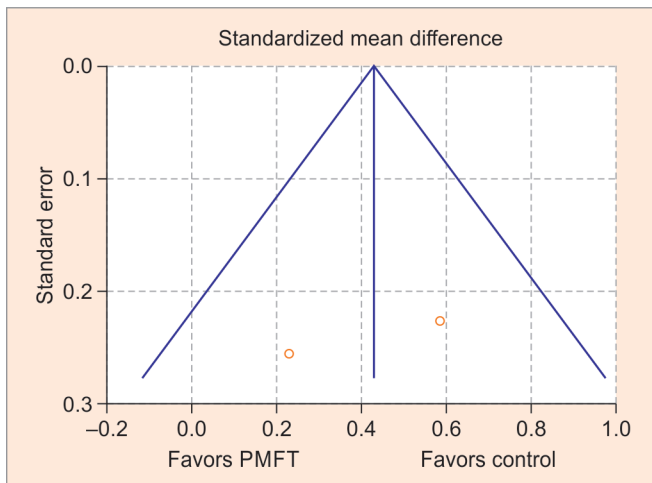
A.4: Funnel Plot – Functional Disability



A.2: Funnel Plot – PFM Strength



A.5: Funnel Plot – Quality of Life



A.3: Funnel Plot – TrA Strength