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REVIEW ARTICLE

The efficacy of pelvic floor muscle training for pelvic organ prolapse: a systematic review and meta-analysis

Chunbo Li[1] · **Yuping Gong**[2] · **Bei Wang**[3]

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Abstract
Introduction and hypothesis Our objective was to assess the effectiveness of pelvic floor muscle training (PFMT) as a treatment for women with pelvic organ prolapse (POP) or as an adjunct to prolapse surgery.
Methods Relevant literature sources were searched using databases including PubMed, Ovid, Web of Science, Scopus, ClinicalTrials.gov, EBSCO, CINAHL, the Cochrane Central Register of Controlled Trials, CNKI, VIP, Wanfang, and CBM until 5 July 2015. Eligible studies were restricted to randomized controlled trials (RCT). The available data were pooled using Review Manager version 5.2. For data deemed not appropriate for synthesis, a narrative overview was conducted.
Results In total, 13 studies with 2,340 patients were included. Our results indicated women receiving PFMT gained a greater improvement than controls in prolapse symptom score [mean difference (MD) −3.07, 95 % confidence interval (CI) −3.91 to −2.23] and POP stages [risk ratio (RR) 1.70, 95 % CI 1.19–2.44]. The number of women who said their prolapse was getting better was higher (RR 5.48, 95 % CI 2.19–13.72) and other discomfort syndromes, such as vaginal, bladder, and rectum, were lower in the PFMT groups than in controls. Meanwhile, women after PFMT had greater improvement in muscle strength and endurance but did not show a significant difference for further treatment needs. In addition, the results evaluating PFMT as an adjunct to prolapse surgery were inconclusive because of the variability in methods of measuring outcome.
Conclusions Our meta-analysis demonstrated women who received PFMT showed a greater subjective improvement in prolapse symptoms and an objective improvement in POP severity.

Keywords Pelvic floor muscle training · Pelvic organ prolapse · Conservative treatment · Meta-analysis

Abbreviations

RCT	Randomized controlled trial
PFM	Pelvic floor muscle
PFMT	Pelvic floor muscle training
BPMT	Behavioral therapy with pelvic floor muscle training
POP	Pelvic organ prolapse
POP-SS	Pelvic organ prolapse syndrome score
POP-Q	Pelvic Organ Prolapse Quantification
RR	Risk ratio
MD	Mean difference
CI	Confidence interval

Introduction

Pelvic organ prolapse (POP) is a common condition characterized by symptomatic descent of the uterus, bladder, and bowel from the normal anatomic position [1, 2]. Approximately 50 % of all parous women suffer from a varying degree of POP [3]. It is reported that about 3–12 % of

✉ Chunbo Li
lichunbo142@126.com

[1] Department of Obstetrics and Gynaecology, Shanghai First Maternity and Infant Hospital, Tongji University School of Medicine, 536 Changle Road, Shanghai 200040, China

[2] Department of General Surgery, Zhongshan Hospital, Fudan University, Shanghai, China

[3] Department of Anesthesia, Zhongshan Hospital, Fudan University, Shanghai, China

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women with symptomatic POP present with a variety of prolapse symptoms [4]. These discomfort symptoms can greatly impair patients' daily activities and quality of life [1, 4].

Current treatment options for POP include surgery and conservative managements [5]. However, surgical treatments are usually associated with increased risks of postoperative complications and prolapse recurrence [6]. Conservative treatments, such as pelvic floor muscle training (PFMT), pessaries, and lifestyle intervention, are often recommended if the prolapse is small or the progressive POP is not the indication for corrective surgery [1, 5]. The theoretical basis of PFMT, which is also known as behavioral therapy of pelvic floor muscle training (BPMT), is that repeated volitional contraction of selected pelvic floor muscles may improve their strength and efficiency, thereby promoting greater support for the pelvic organs [7, 8]. The latest evidence indicated that women with symptomatic mild prolapse or urinary incontinence benefited from PFMT [1, 9, 10]. Studies indicated PFMT could effectively support the pelvic organ in the normal anatomic position by contracting pelvic floor muscles before and during any increase in abdominal pressure [5, 11]. In addition, structural support of pelvic floor muscles is significantly improved by performing PFMT [2]. According to a Cochrane Review, PFMT should be recommended as the first-line conservative management for stress urinary incontinence [12]. However, clear evidence about whether PFMT could improve the severity of prolapse is still scarce. Up to date, only one meta-analysis by Hagen et al. that consisted of six studies has been published, in which two studies showed a positive effect of PFMT as an adjunct for women undergoing corrective surgery and four trials demonstrated that PFMT as a treatment for women with POP resulted in a significant improvement of prolapse symptoms and severity of POP as compared to controls [9]. However, the lower methodological quality of the trials included as well as a very low number of participants in their meta-analysis made clinical use of these data limited. They concluded that reliable evidence from high-quality randomized trials was necessary for gaining more powerful conclusions [9]. In the last few years, several randomized trials that assessed the efficacy of PFMT as a treatment for women with POP or an adjunct to prolapse surgery were published [13–19]. However, individual studies showed conflicting results on the benefits of PFMT. Thus, it is necessary to include all published and unpublished evidence to evaluate the efficacy of PFMT in women with POP.

Based on these considerations, the aim of this study was to perform a meta-analysis of all available literature to obtain updated evidence on the efficacy of PFMT for women with POP. The main outcomes of interest were the change of prolapse symptom score, the change of prolapse symptoms or prolapse severity, pelvic floor muscle (PFM) assessment, and further treatment needs after PFMT intervention as compared to controls. The secondary outcomes of interest evaluated the efficacy of perioperative PFMT intervention as an adjunct for women with POP undergoing corrective surgery.

Materials and methods

Search strategy

The electronic databases including PubMed, Ovid, Web of Science, Scopus, ClinicalTrials.gov, EBSCO, CINAHL, and the Cochrane Central Register of Controlled Trials were searched for relevant literature published in English. For literature published in Chinese, the following databases including China National Knowledge Infrastructure (CNKI), Database of Chinese Scientific and Technical Periodicals (VIP), Wan Fang database, and the China biology medical literature database (CBM) were used to search. In order to identify all scientific articles, the last search for all databases was performed on 5 July 2015. A combination of the following medical subject headings (MeSH) or keywords was included: "conservative treatment," "pelvic floor muscle training," "PFMT," "behavioral therapy," "physiotherapy," "pelvic organ prolapse," and "POP." In addition, the reference lists of all identified articles were examined to identify studies not captured by electronic searches. The electronic search and the eligibility of the studies was assessed by two independent authors (CB.L and B.W). Differences were resolved by discussing with a third author (YP. G).

Study selection

Studies were included if they met the following criteria: (1) the type of a study should be a randomized trial; (2) all participants in each study should be women with different stages of POP as determined by the Pelvic Organ Prolapse Quantification (POP-Q) system (postpartum women or women with stage IV prolapse were excluded); (3) as for the type of intervention, participants received any types of PFMT programs, including the usage of variations in the ways of teaching PFMT, type of contractions (fast or sustained), and number of contractions; (4) as for the controls, all participants did not receive treatment or intervention without a PFMT program involved; and (5) as for the outcome, a study should report at least one of the outcomes as mentioned below, such as the change in subjective prolapse syndrome score, the number of patients reporting an improvement in prolapse syndrome, and the change of prolapse severity stage based on the POP-Q data as well as PFM evaluation and further therapy needs.

A study was excluded from the meta-analysis for the following reasons: (1) if it was a retrospective comparative study (cohort or case–control study), an editorial, a letter to the editor, a review, a case, or a study of an animal experiment; (2) if

more studies involved in the same trial were reported by the same surgical authors and showed an overlap between the results; (3) if the necessary data were extrapolated from the reported outcomes; (4) if the outcomes of interest were not described evidently; and (5) if it evaluated the efficacy of PFMT for stress incontinence or other types of pelvic organ dysfunction.

Data abstraction

All data from the included studies were screened and extracted by two authors independently. The extracted information included authors, year of publication, country, number of patients, age, body mass index, intervention procedure, control, and duration of follow-up. To ensure completeness and accuracy of the extracted data, the two investigators abstracted data from the included studies and then cross-checked their tasks. At these stages, if there was any disagreement between the two reviewers, a final decision was made by discussion with a third author. If necessary, the authors of the eligible trials were contacted by phone, fax, or e-mail to obtain missing information. The characteristics of eligible studies are presented in Table 1.

Study quality

The risk of bias was assessed by two independent authors in accordance with the *Cochrane Handbook for Systematic Reviews of Interventions* [20]. The following seven domains related to risk of bias were evaluated for each trial: (1) random sequence generation, (2) concealment of treatment allocation, (3) blinding of participants and personnel, (4) blinding of outcome assessment, (5) incomplete outcome data, (6) selective reporting, and (7) other bias. For each criterion, a score of "+" (low risk of bias), "−" (high risk of bias), or "?" (risk of bias is unclear from the article) was assigned. Disagreement was resolved by discussion with a third author.

Statistical analysis

The data of included trials were analyzed by two independent authors using Review Manager software (version 5.2, Nordic Cochrane Centre). For the continuous data, mean and standard deviation (SD) were used to calculate the weighted mean difference (WMD) and 95 % confidence interval (CI). In respect to the dichotomous data, risk ratio (RR) with 95 % CI was applied. Statistical significance was set at $P<0.05$ to summarized findings across the trials. The statistical heterogeneity among the outcomes of combined trials was assessed using the chi-square and I^2 tests. The pooled rate of all studies was calculated as the weighted average rate by using the fixed effects model or random effects model according to the result of the I^2 test. An I^2 value of 50 % was considered to be suggestive of substantial heterogeneity, which prompted the usage of a random effects model. Otherwise, a fixed effects model was used for the analysis. Sensitivity analyses were conducted by removing the studies with a high risk of bias in order to explore the impact of study quality on the effect size for the outcomes of interest. We had enough confidence in the strength and robustness of our findings if there were no substantial discrepancies for the above approach.

Results

Characteristics of the included studies

There were 9,577 studies (8,425 in English databases and 1,152 in Chinese databases) identified based on a defined search strategy. Subsequently, 8,962 articles (7,821 in English databases and 1,141 in Chinese databases) were excluded by screening the title and abstract, leaving 615 studies (604 in English databases and 11 in Chinese databases) for further evaluation. After obtaining and thoroughly reviewing the complete manuscript of each study, 599 studies (588 in English databases and 11 in Chinese databases) which did not meet the inclusion criteria were further excluded and the remaining 16 studies were appraised critically. A study by Bø et al. [21] evaluating the efficacy of PFMT in young primiparous postpartum women with a mean age of 29.5 and a study by Resende et al. [22] assessing whether hypopressive exercises could provide additional benefits than PFMT were further excluded. One trial published in 2015 by Brakken et al. [15] reported the effect of PFMT on sexual function in which the data came from their previous trials [23], and thus the two trials were combined. Finally, 13 articles [13, 14, 16–19, 23–29] were eligible for systematic review after critical evaluation. Of the 13 studies, 1 study [25] was published in French with an English abstract, which was translated to obtain a reasonable amount of information and 12 trials [13, 14, 16–19, 23, 24, 26–29] were presented in English. Nine trials [13, 16, 17, 19, 23, 25–27, 29] evaluated the efficacy of PFMT as a treatment for patients with POP and four trials [14, 18, 24, 28] evaluated the efficacy of PFMT as an adjunct to corrective surgery for patients with POP. The study selection process is summarized in Fig. 1.

The main characteristics of the population in the identified studies are summarized in Table 1. The participants in all trials suffered from varying degrees of POP. Of the nine trials that evaluated the efficacy of PFMT as a treatment for women with POP, the program duration varied between 4 weeks and 6 months in seven studies [13, 16, 19, 23, 25, 26, 29]. However, two studies [17, 27] did not present sufficient detail on the duration of PFMT intervention. The frequency of voluntary contractions in the trials ranged from 20 to 60 repetitions daily with the duration of holding per contraction from 6

Table 1 Characteristics of included trials

First author	Year	Country	Age (years)	BMI (kg/m^2)	Study population	Intervention (n), control (n)	Parity (n) (mean±SD)	PFMT method	Control	Duration of follow-up
PFMT as a treatment for POP										
Hagen										
PFMT	2014	UK	56.2±11.6	27.15±4.99	Women with POP stages I, II, and III	225	2 (2–3)	PFMT home Over 16-week period 3 sets daily 50 or more contractios/day	None	48 weeks with 5 follow-up visits
Control			57.5±11.39	27.42±4.57		222	2 (2–3)			
Brakken										
PFMT	2010	Norway	49.4±12.2	25.8±3.8	Women with POP stages I, II, and III	59	2.4±0.8	PFMT home Over 6-month period 3 sets daily 8–12 contractions/set	Patients taught how to contract PFM were asked not to start	24 weeks
Control			48.3±11.4	26.18±5.3		50	2.4±0.7			
Hagen										
PFMT	2009	UK	56±9	NC	Women with POP stages I and II	23	NR	PFMT home Over 16-week period 6 sets daily 10 or more contractions/set	None	16 weeks
Control			56±9			24				
Wiegersma										
PFMT	2014	Netherlands	64.5±6.8	27.0±4.7	Women with POP stages I and II	145	2.4±1.2	PFMT home 4-week period 2 or 3 sets daily	None	24 months
Control			64.0±6.5	26.6±4.8		142	2.4±1.1			
Stupp										
PFMT	2010	Brazil	52.95±6.4	29.9±3.5	Women with POP stage II	21	3.2±2.2	PFMT home Over 14-week perio; 3 sets daily 8–12 contractions/set	Patients taught how to contract PFM were asked not to start	14 weeks
Control			58.12±9	29.7±2.7		16	4±3.2			
Kashyap										
PFMT	2012	India	46 (23–70)	NR	Women with POP stages I, II, and III	70	3±1.23	PFMT home 3 sets daily 10 voluntary contractions/set	None	24 weeks
Control			47 (25–70)			70	3±1.44			
Piya-Anant										
PFMT	2003	Thailand	67.0±5.6	NR	Women with POP	330	NR	PFMT home 30 contractions/day	None	24 months
Control			67.7±5.7			324				
Alves										
PFMT	2015	Brazil	66.11±8.72	29.43±3.91	Women with POP stages I, II, and III	18	3.56±2.79	PFMT home 6-week treatment 2 weekly with 30 min duration 12 sessions	Only physical fitness sessions without PFMT	6 weeks
Control			65.67±9.21	31.52±5.71		12	3.92±2.11			
Ghroubi										
PFMT	2007	Tunisia	53.42±11.01	NR	Women with stage I or II cystocele	27	NR	PFMT home 12-week treatment 20 contractions/day	None	2 years
Control			53.42±11.01			20				

Table 1 (continued)

First author	Year	Country	Age (years)	BMI (kg/m^2)	Study population	Intervention (*n*), control (*n*)	Parity (*n*) (mean±SD)	PFMT method	Control	Duration of follow-up
					with or without stage I rectocele			24 sessions		
PFMT as an adjunct to prolapse surgery										
McClurg										
PFMT	2014	UK	60 (35–80)	27±3.0	The most common prolapse stage was II	28	2.19±0.83	PRE: 3 sets daily; 10 contractions POST: lifestyle advice leaflet OUT: PFMT home; 12 weeks treatment, biofeedback, electrical stimulation, and exercise balls	A lifestyle advise leaflet without PFMT treatment	12 months
Control						29				
Barber										
PFMT	2014	UK and USA	57.5±10.9	29.3±5.6	Women undergoing vaginal surgery for stage II–IV prolapse	186	3	Participants received perioperative PFMT, received an individualized program that included one visit 2–4 weeks prior to surgery, and 4 post operative visits (2, 4–6, 8, and 12 weeks after surgery)	None	24 weeks
Control			56.9±10.9	28.4±5.3		188	3			
Frawley		Australia								
PFMT	2010		57.4±10.3	27.6±4.4	Women who were having vaginal surgery for repair of prolapse	27	NR	PRE: 3 sets daily; 8–12 contractions POST: reduction of intensity of PFMT and gradual increase OUT: PFMT home; maintenance PFMT for 3–6 months, then reduction to 1–2 sets daily	Patients received similar lifestyle advice and PFM exercise, but without supervision	12 months
Control			55.8±10.7	25±3.5		24				
Jarvis										
PFMT	2005	Australia	62.6±10.5	27±4.2	Women who were scheduled to undergo surgery to correct prolapse	30	2.5±1.1	NR	NR	12 weeks
Control			62.8±11.1	27.4±2.8		30	2.6±1.2			

PFMT pelvic floor muscle training, *PFM* pelvic floor muscle, *PRE* preoperation, *POST* postoperation, *OUT* outpatient, *SD* standard deviation, *NR* no report

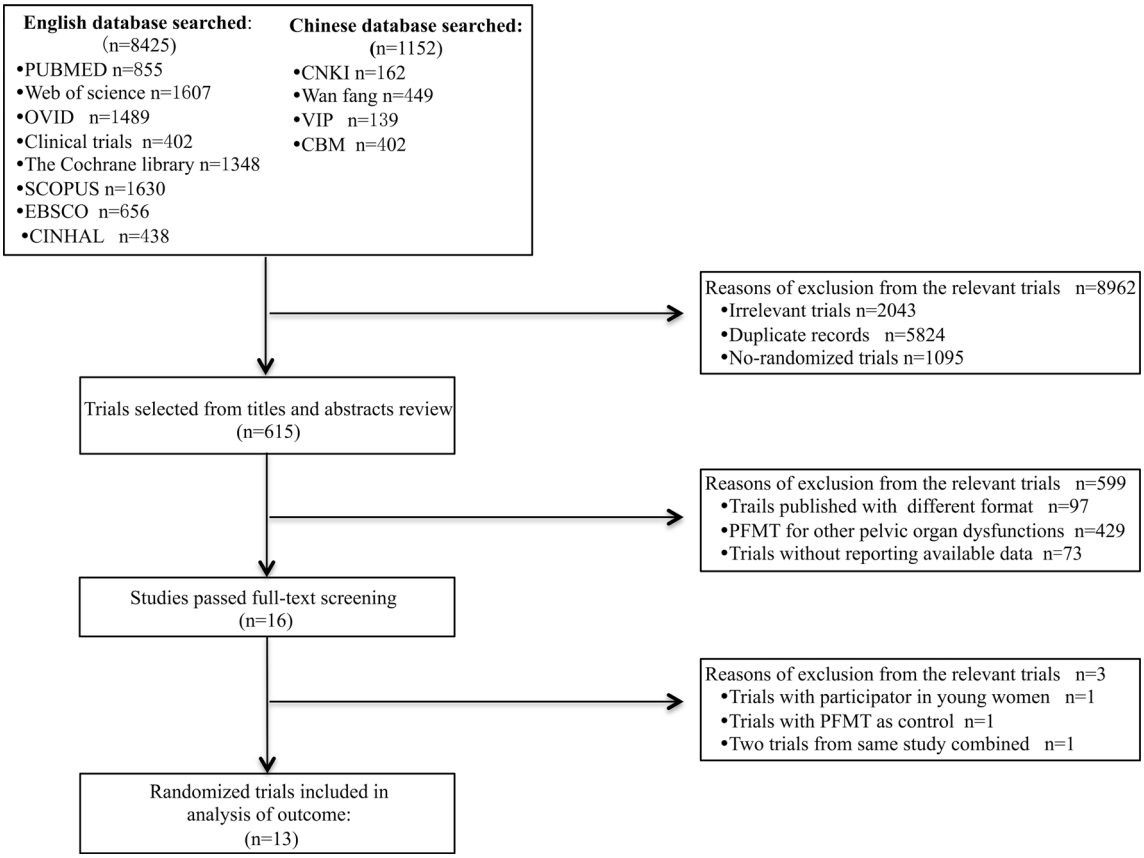

Fig. 1 Selection process for the studies included in the meta-analysis

to 12 s. For the remaining four trials [14, 18, 24, 28] that evaluated the efficacy of PFMT as an adjunct to corrective surgery, the frequency, intensity, and duration of PFMT differed from study to study. All trials reported that a physiotherapist monitored the procedure of PFMT to perform a correct PFM contraction before training.

Risk of bias

The quality of the included trials is detailed in Fig. 2. Of the 13 included studies, 3 trials [23, 25, 27] were classified as having unclear sequence generation and 3 different trials [25, 27, 29] have unclear allocation concealment. The blinding method was unclear in one study [25], whereas two trials [17, 27] were unblinded. The outcome data were incomplete in one study [27] and unclear in one study [25]. The selective outcome reporting was inadequate in two trials [25, 27], and the other risk of bias was unclear in the same studies [25, 27].

Synthesis of results

Two trials [16, 26] enrolling 414 patients (PFMT group=205, control group=209) reported the change in prolapse symptom score after PFMT intervention. The pooled results showed that pelvic floor organ syndrome score (POP-SS) from baseline to follow-up had a significant reduction after PFMT intervention as compared to controls (MD −3.07, 95 % CI −3.91 to −2.23) (Fig. 3a). Five trials [16, 17, 19, 26, 27] with a total of 1,449 patients (PFMT group=721, control group=728) reported the number of patients who felt their prolapse better after PFMT intervention was higher (i.e., self-reported change in prolapse) as compared to controls (RR 5.48, 95 % CI 2.19–13.72) (Fig. 3b). In addition, our study also showed that the bothersomeness of vaginal bulging, urinary incontinence, and bowel syndrome including fecal urgency/incontinence had a significant improvement after PFMT intervention as compared to controls (Table 2). These findings indicated that PFMT intervention could improve the subjective symptoms of POP than in the control group.

Four trials [16, 17, 23, 26] with a total of 607 patients (PFMT group=307, control group=300) reported the change in prolapse severity defined by the POP-Q system. The pooled results showed significantly greater improvement in POP-Q stage after PFMT intervention as compared to controls (RR 1.70, 95 % CI 1.19–2.44) (Fig. 4a). Subgroup analysis evaluated the effect of PFMT on anterior [19, 29], posterior [19, 29], and apical [19] vaginal wall prolapse as compared to controls. The pooled results showed that PFMT resulted in a greater improvement for anterior prolapse (RR 2.15, 95 % CI 1.38–3.35) but not for posterior prolapse (RR 1.25, 95 % CI 0.64–

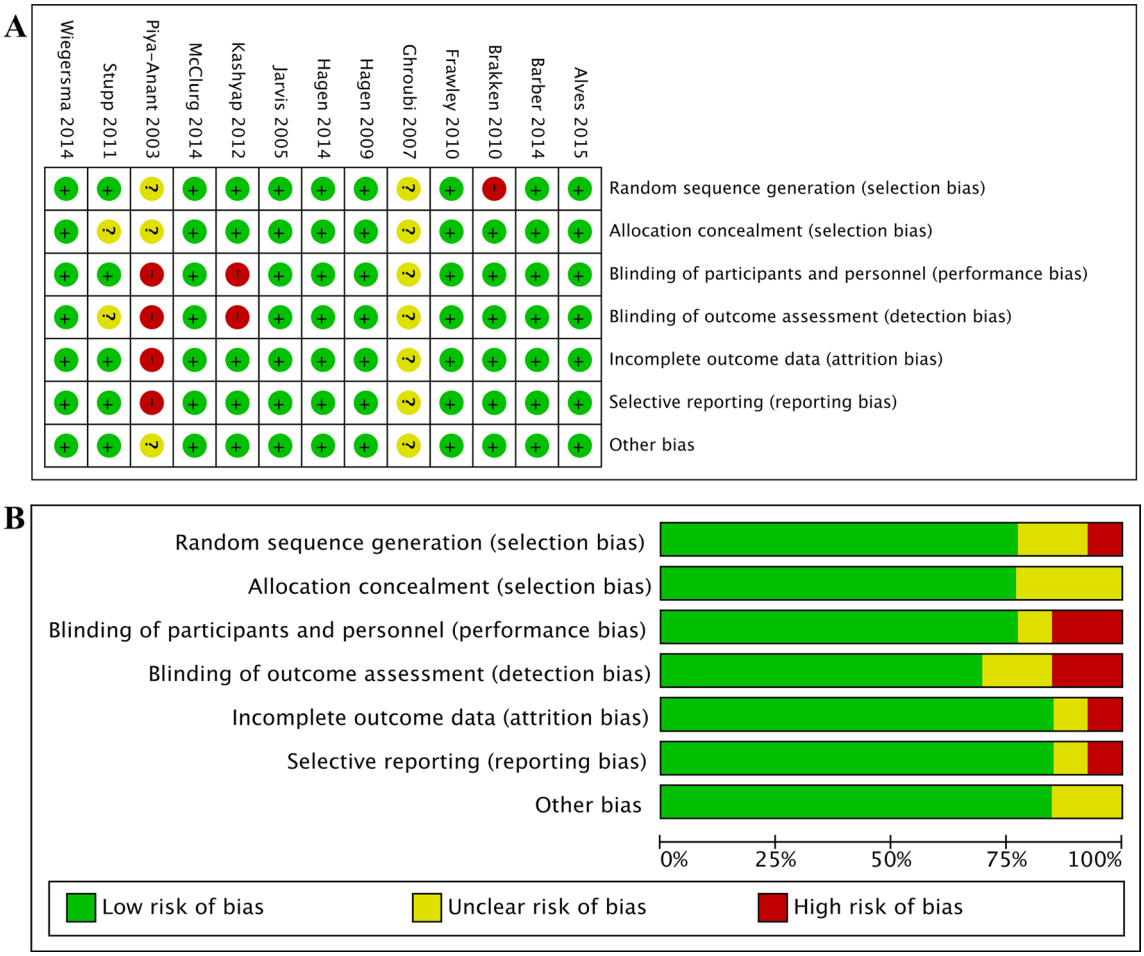

Fig. 2 Methodological quality of the studies included in the meta-analysis

2.43) as compared to controls (Fig. 4b, c). Because only one study evaluated the efficacy of PFMT for apical vaginal wall prolapse, we could not gain a pooled result. These findings indicated PFMT intervention could improve the objective symptoms of POP. However, the results should be interpreted with caution due to the few trials included.

Only one trial [19] with a total of 109 patients (PFMT group=59, control group=50) evaluated the

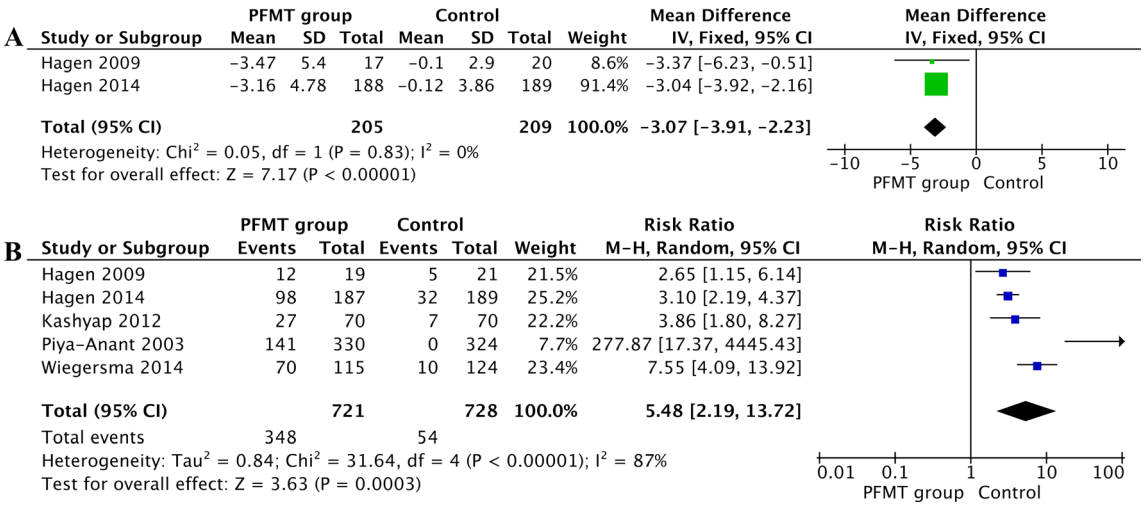

Fig. 3 Forest plot showing the effect of PFMT on the pelvic floor organ syndrome score (**a**) and self-reported change in prolapse syndromes as compared to baseline (**b**)

Table 2 Meta-analysis of other adverse syndromes such as vaginal bulging and/or heaviness, bladder, and bowel

Variable	Study	PFMT/control (*n*)	RR (95 % CI)	Z	χ^2	I^2	*P*	Model
Vaginal bulging and/or heaviness								
Reduced frequency	1	43/26	2.42 (1.32–4.42)	2.87	–	–	0.004	Fixed
Reduced bother	4	161/132	5.45 (2.10–14.13)	3.49	6.82	56 %	0.0005	Random
Bladder								
SUI: reduced frequency	1	39/27	2.51 (1.36–4.62)	2.96	–	–	0.003	Fixed
SUI: reduced bother	3	87/63	3.64 (1.98–6.69)	4.15	3.87	48 %	<0.0001	Fixed
UUI: reduced frequency	1	27/12	1.78 (0.75–4.20)	1.31	–	–	0.19	Fixed
UUI: reduced bother	3	75/48	2.73 (1.20–6.23)	2.39	3.33	40 %	0.02	Fixed
Bowel								
Empty: reduced frequency	1	25/15	1.50 (0.75–3.01)	1.14	–	–	0.25	Fixed
Empty: reduced bother	2	46/31	1.07 (0.60–1.89)	0.22	0.01	0 %	0.82	Fixed
FI: reduced frequency	1	17/10	2.55 (1.95–6.81)	1.87	–	—	0.06	Fixed
FI: reduced bother	2	242/234	2.79 (1.34–5.84)	2.73	1.07	6 %	0.006	Fixed
FU: reduced frequency	–	–	–	–	–	–	–	–
FU: reduced frequency	1	225/222	1.97 (1.21–3.22)	2.72	–	–	0.007	Fixed

PFMT pelvic floor muscle training, *CI* confidence interval, *RR* risk ratio, *SUI* stress urinary incontinence, *UUI* urge urinary incontinence, *Empty* difficulty emptying bowel, *FI* fecal incontinence, *FU* fecal urgency

change of PFM after PFMT intervention. The results showed a greater improvement in PFM strength and endurance after PFMT intervention as compared to controls (data not shown). The effect size for muscle strength and endurance was 1.21 and 0.96, respectively. However, because of the few trials included in our

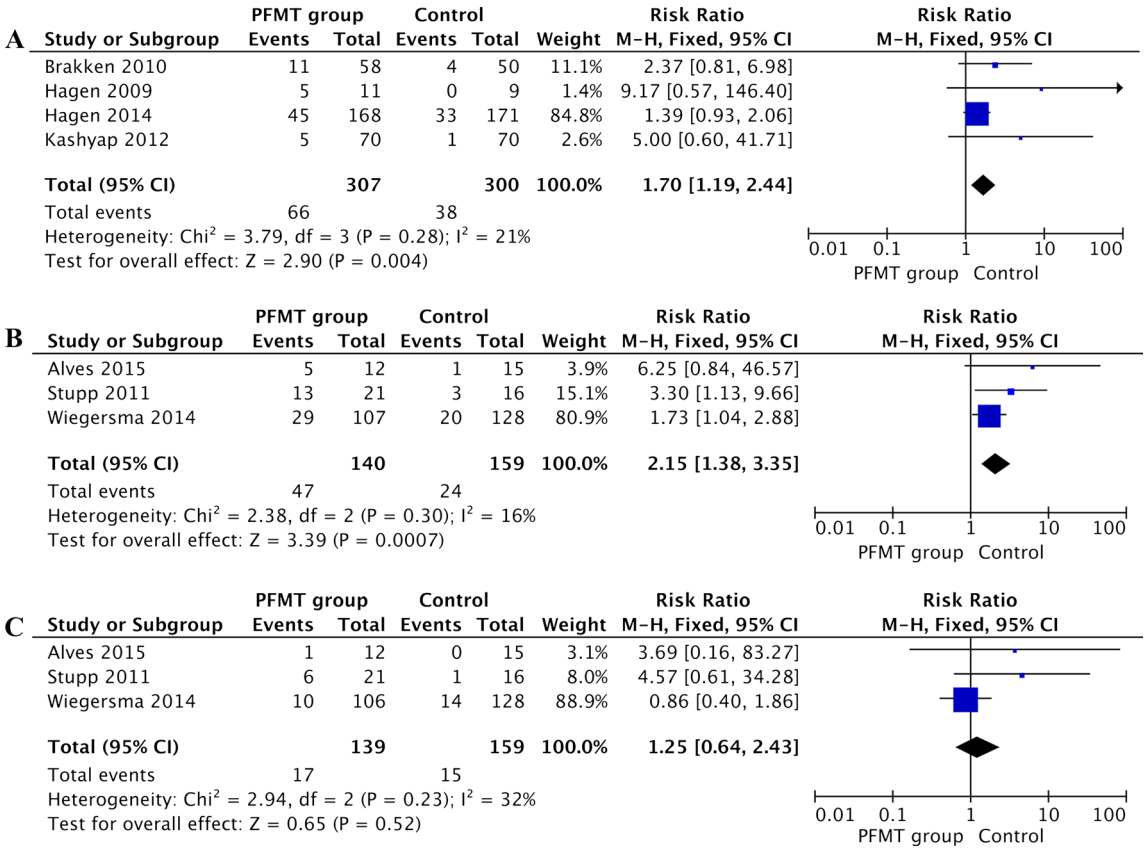

Fig. 4 Forest plot showing the effect of PFMT on severity stage of pelvic organ prolapse (**a**), anterior vaginal wall prolapse (**b**), and posterior vaginal wall prolapse (**c**)

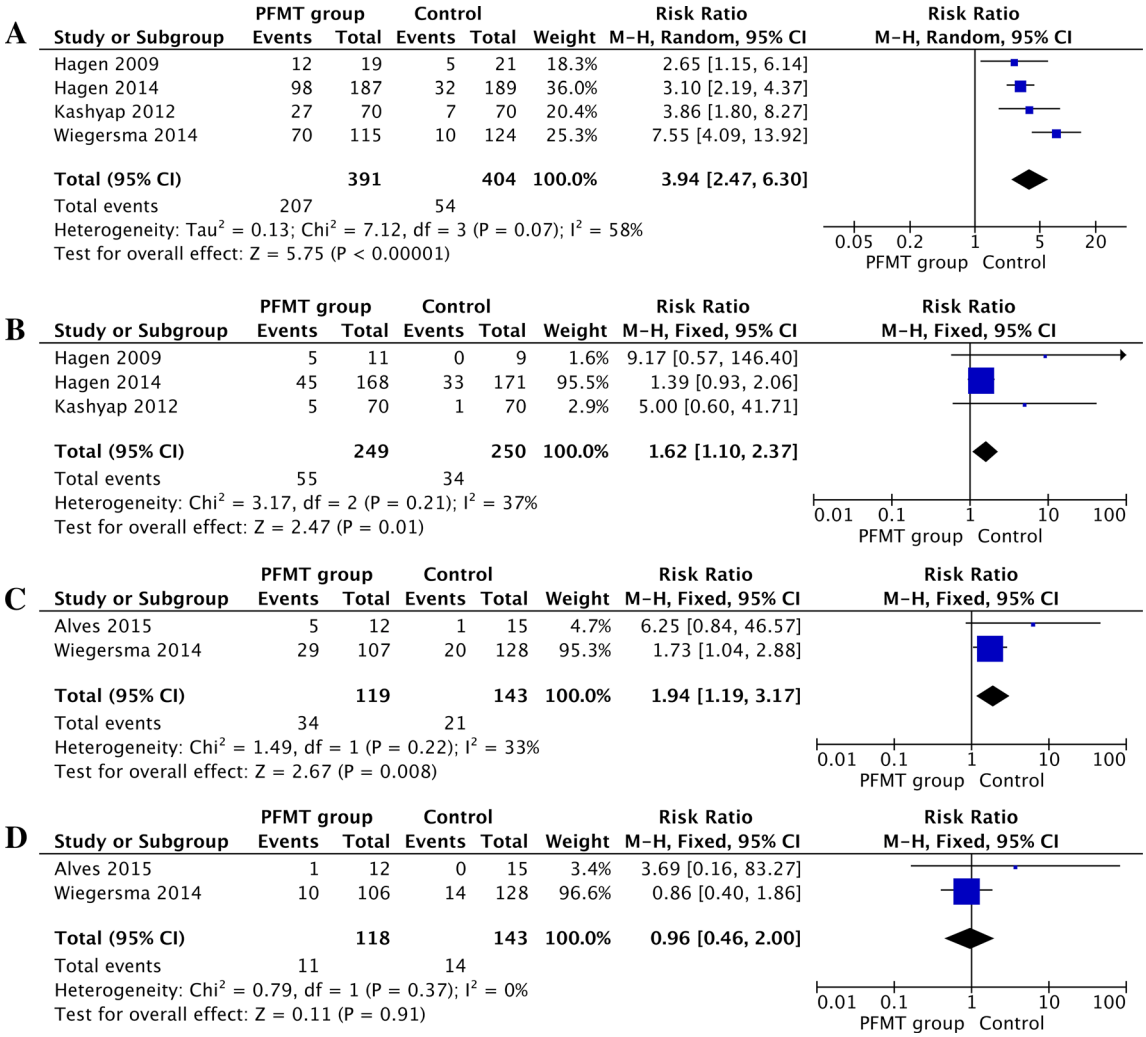

Fig. 5 Sensitivity analysis. Forest plots of self-reported change in prolapse syndrome (**a**), severity stage of POP (**b**), anterior vaginal wall prolapse (**c**), and posterior vaginal wall prolapse (**d**) for studies with high quality

meta-analysis, the data were deemed inadequate, and thus the results did not seem to be reliable.

Detailed data from one trial [19] by Hagen et al. reporting the number of patients who received further treatment after PFMT intervention were available. The results showed that women with PFMT intervention had similar rates for surgery, pessary, and other non-trial treatments such as estrogen or other drugs, but resulted in a significant reduction in physiotherapy referral as compared to controls (data not shown). However, the findings are based on one trial, and thus the result should be noted with caution.

Four trials [14, 18, 24, 28] reported PFMT as an adjunct to prolapse surgery. However, because of the variability in methods of measuring outcome and in definition of POP stage, the data were deemed inappropriate for synthesis, so a narrative overview was presented. A trial [28] by Jarvis et al. recruited 60 women who were scheduled to have surgery to correct prolapse and evaluated the efficacy of PFMT as an adjunct to prolapse surgery. Their results showed that women with a preoperative and two postoperative PFMT interventions showed a significant improvement in physical outcome and quality of life as compared to controls. However, Frawley et al.'s trial [24] with 58 women demonstrated thata PFMT program combined with surgery did not improve bladder or prolapse symptoms after 12 months of follow-up. Recently, the OPTIMAL randomized trial [14] with 374 women also demonstrated that perioperative PFMT did not improve urinary symptoms at 6 months or prolapse outcomes at 2 years postoperatively. A pilot study [18] by McClurg et al. noted a discrepancy for evaluating PFMT as an adjunct to prolapse surgery.

Sensitivity analysis and publication bias

We repeated the analysis for outcome of interest by including only high-quality studies. Pooling of data was feasible for only one outcome of interest, i.e., the change of prolapse severity defined by POP-Q. After excluding three studies by

Piya-Anant et al., Brakken et al., and Stüpp et al. [21, 25, 27], our pooled results were not materially differentiated compared with those of the original analysis (Fig. 5a–d). Because of the limited number of trials included in our meta-analysis, we did not evaluate the publication bias.

Discussion

Our findings showed a subjective improvement in prolapse symptoms and an objective improvement in severity of POP in women who underwent PFMT as compared to controls. In addition, PFMT intervention could reduce bladder prolapse (stress urinary incontinence, urge urinary incontinence), bowel (flatus, loose stool, fecal incontinence), and vaginal symptoms (vaginal bulging and/or heaviness). Meanwhile, PFMT intervention had a potential effect on muscle strength and endurance but did not show a significant difference for further treatment needs. For PFMT as an adjunct to prolapse surgery, the results from the trials included were inconclusive because of the variability in methods of measuring outcome.

Our pooled results demonstrated that PFMT intervention had a positive effect on prolapse symptoms for women with POP and the number of these women who felt their prolapse syndrome was better after PFMT intervention was higher as compared to controls. However, it must be noted that more heterogeneity existing among the included trials made the interpretation of the findings more challenging. In addition, a relatively small sample size included in our study might introduce bias and lower the reliability of results. The position of the bladder and rectum is usually recommended as markers for indicating the severity of anterior and posterior compartment prolapse [30]. Vaginal bulging and heaviness are considered as the most discriminatory symptoms in women with POP [11]. Our findings showed that women who underwent PFMT gained a significant improvement in all of the bladder, bowel, and vaginal bulging syndromes, which was related to a better quality of life. The improved subjective symptoms of bladder, bowel, and vagina are considered the most important treatment targets because these symptoms are the main indication for prolapse surgery [30, 31]. However, it should be noted that bladder and bowel symptoms may exist without POP and are considered by most studies as coexisting symptoms, rather than unique symptoms of POP [32]. The low number of participants in the studies included might lower the reliability of conclusions. In addition, we did not present the result of how much the syndrome interfered with daily life due to the different types of instruments used and low number of participants among the included trials. Thus, further studies are needed to elucidate the association between these adverse syndromes in POP and quality of life.

The POP-Q system, defined by six points, two (Aa, Ba) on the anterior vaginal wall, two (C, D) on the superior vagina, and two (Ap, Bp) on the posterior vaginal wall, is used to objectively evaluate the severity of prolapse of pelvic organs [33]. In the present study, our findings showed a significant improvement in POP-Q stage by evaluating the POP severity stage and anterior vaginal wall. It must be pointed out, however, that the findings should be interpreted with caution because of the unavailability of evidence regarding the frequency, intensity, and duration of PFMT intervention. Two trials [13, 29], in which participants received PFMT for about 16 weeks, had findings in favor of the experimental group, whereas one trial [19] by Wiegersma et al. commenced exercise for 12 weeks but did not find a significant benefit from PFMT. It could be hypothesized that a short duration of PFMT might just provide time for awareness of the pelvic floor muscles, while a longer exercise period to enhance strength and endurance would provide greater benefit. It had been reported that a duration of PFMT at least 16 weeks might be necessary to gain muscle hypertrophy [1]. Another critical issue is the frequency of PFMT interventions. Novara and Artibani [34] pointed out that the greater the frequency of PFMT, the better its efficacy, regardless of the method chosen. In addition, the different treatment protocols of PFMT from study to study might also cause more heterogeneity. Finally, there was no standardized definition of POP and the percentage of subjects with different POP stages at baseline varied among the included trials, and the results therefore might not be generalizable. Even so, all included trials reported that women received a regular and rigorous supervision during the treatment procedure, which could effectively lower the discrepancy. Thus, we had enough confidence to draw a conclusion that PFMT treatment could not only result in a subjectively significant improvement in prolapse syndrome but also objectively acquire a satisfied outcome in severity of prolapse.

Pelvic organs are mainly supported by the levator muscles and stabilized by the pelvic ligaments [35]. Pregnancy and vaginal delivery may cause weakness of the pelvic floor muscles [36]. Generally, adequate PFMT could provide better support to these organs and improvements in PFM strength are the aims of PFMT intervention [37]. Our findings indicated that PFMT intervention resulted in a significant increase in PFM strength and endurance and subsequently improvement in prolapse symptoms. However, there was only one trial with a total of 109 patients evaluating the effect of PFMT on PFM strength and endurance. Thus, it was not possible to pool an effect size for the meta-analysis. More high-quality randomized controlled trials (RCT) in this area are needed for this situation.

For further treatment needs such as surgery, pessary, drugs (for example, an anticholinergic), and other physiotherapy referral, our results showed no significant effect of PFMT on other treatment needs such as surgery, pessary, and drugs but not physiotherapy referral as compared to controls. However, the result should be interpreted with caution. In our study, only

two trials [14, 16] reported the number of subjects who needed further treatment. For example, Hagen et al. [16] reported that 11 % of patients needed surgery after PFMT, while Barber et al. [14] reported 2.6 %. The possible reason was that the criteria for further treatment needs were not well established, which might result in more discrepancy. In addition, the indication and the tolerance of patients to different types of treatment were different, which might result in an important effect on treatment options. Thus, the pooled results for women who needed further treatment were not reliable and more trials are needed to get robust evidence. However, for the discrepancy of physiotherapy referral, the possible interpretation was that women in the control group who suffered from continuous discomfort had more desire for conservative treatment and favored PFMT due to their understanding of POP and other doctors' or patients' advice.

Four trials [14, 18, 24, 28] evaluated PFMT as an adjunct for enhancement of surgical treatment of which two studies [18, 28] presented that PFMT intervention could improve physical outcomes and quality of life in women who undergo prolapse surgery for POP, while two trials [14, 24] showed that PFMT in conjunction with surgery had no effect on improving prolapse symptoms. The OPTIMAL randomized trial [14] with 374 women undergoing surgery proposed that perioperative PFMT was likely unnecessary as a routine aspect of perioperative care. With only four of the studies examining these outcomes, there were limited data that related to the efficacy of PFMT for prolapse surgery. In addition, results across studies for some outcomes were unable to be synthesized convincingly due to the uncertain criteria of evaluating the prolapse syndrome and quality of life. All studies concluded that more high-quality RCT in the area were needed for this situation. Nevertheless, we would like to emphasize the necessity of randomized and well-designed trials to assess the effect of PFMT on surgery and the need to conduct new research to achieve a strong conclusion.

As is often the case with a meta-analysis, the potential limitations of this meta-analysis should be considered. First, we could not perform a subgroup analysis by different time points (short-term, intermediate-term, and long-term) because of an insufficient number of qualified RCT with a very low number of participants among the included trials, which was a source of bias affecting the pooled results. It seemed that POP progressed gradually with increasing time after PFMT treatment, but it was not clear how many millimeters the pelvic organs normally descend over time. Second, the percentages of subjects with different POP stages varied from study to study, which might affect the effect of PFMT. Third, the procedures of PFMT protocol varied among the included studies as regard to frequency, intensity, and duration, which might be a key reason leading to the moderate heterogeneity when evaluating the association between PFMT intervention and POP. Finally, like any systematic review, ours was limited by the quality of the original data.

Conclusion

Based on the available evidence, our meta-analysis demonstrated that the applied PFMT program could be an effective way to improve prolapse symptoms and POP stage as compared to controls. PFMT intervention also significantly increased PFM strength and endurance but had no significant effect on further treatment needs. For PFMT as an adjunct to prolapse surgery, the results from the included trials were inconclusive because of the variability in methods of measuring outcomes. Thus, further pragmatic trials are warranted based on the same protocol, and longer follow-up studies are needed to confirm or refute the results presented in our meta-analysis.

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