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REVIEW ARTICLE

The effect of pelvic floor muscle-strengthening exercises on low back pain: a systematic review and meta-analysis on randomized clinical trials

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Abstract

Background Low back pain is a musculoskeletal disorder (MSD), and Kegel exercise is considered as one of the non-surgical management methods. Therefore, the present systematic review and meta-analysis aimed to estimate the results of randomized clinical trials (RCT) about the effect of pelvic floor muscle-strengthening exercises on reducing low back pain.

Methods The present study was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guideline (2020) to January 2022. The relevant studies were searched in the MagIran, SID, PubMed, Embase, Web of Science (WoS), Scopus, ClinicalTrials.gov databases and Google Scholar motor engine using related MeSH/Emtree terms, which were combined with free text word. The heterogeneity of the studies was checked using I^2 statistic.

Results Finally, 19 RCTs with a sample size of 456 subjects in the intervention group and 470 in the control group were included in the meta-analysis. The low back pain intensity in the intervention group decreased up to 1.261 ± 0.213 (SMD ± 95% CI) with $I^2 = 87.60$ more than that in the control group ($P < 0.001$). The low back pain intensity in postpartum women decreased up to 1.614 ± 0.312 (95% CI) followed by pregnant women as 1.282 ± 0.479 (SMD ± 95% CI) more than that in other populations. But due to high the heterogeneity in all sub-groups ($I^2 > 80\%$) this result should be considered with caution. Meta-regression analysis showed the effect of pelvic floor muscle-strengthening exercises increased by increasing the year of publication, quality assessment score of the article, and the number of weeks of intervention ($P < 0.05$).

Conclusion Based on the results of the present meta-analysis, pelvic floor muscle-strengthening exercises significantly reduce the low back pain intensity. Therefore, these exercises can be regarded as a part of a low back pain management plan.

Keywords Pelvic floor · Back pain · Resistance training · Systematic review · Meta-analysis · Exercise

Introduction

Low back pain is a musculoskeletal disorder, influencing the lumbar vertebrae of the spine, and statistics show that about 90% of people are affected by this disorder at least once in their lifetime [1–3]. Lower back pain can result from many causes, but the main causes can be due to traumatic injury, genetic factors, lifting heavy objects, muscle weakness, aging, and weight [1, 4].

In different studies, the prevalence of this complication has been reported between 18 and 80% in different populations [5, 6]. Lower back pain is divided into three categories based on the duration of symptoms since its onset. Acute lower back pain is defined as a pain that has been present for less than 4 weeks, sub-acute lower back has 4- to 8-week duration, and chronic lower back pain lasts longer than 8 weeks since its onset. Of which, chronic lower back

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pain is more important, which accounts for about 20% of lower back pain [7, 8]. The incidence of lower back pain and its complications disrupt daily activity, social function, and psychological health. It can also negatively influence the family and community economics [9].

In the medical field, there have always been attempts to control lower back pain using various methods, since the effective treatment of lower back pain prevents the occurrence of harmful physiological and psychological consequences of this phenomenon, which is very important from the patient and economic perspective [10, 11]. The lower back pain is treated using pharmacological therapies, such as painkillers, anti-inflammatory drugs, and non-pharmacological therapies, including surgery and non-surgical treatment [12].

Kegel exercises (pelvic floor and perineal muscles exercises), as a non-surgical method for treating lower back pain, were introduced by Kegel (1948) to improve the relaxation and atrophy of the pelvic floor muscles. Its beneficial goals are to reduce pain and the feeling of heaviness in the pelvic. These exercises help strengthen the vulva area, the perineal muscles, and pelvic floor muscles, accelerate recovery, prevent pelvic floor muscle relaxation syndrome, and improve some chronic disease. It also assists the patient in urinating and defecating [13–15].

Kegel exercise is painless, and uncomplicated, which can be done at any time of the day or night. These exercises are associated with tightening and relaxing the pelvic floor muscles. The most important thing is to find the right muscle. These muscles are those that can be voluntarily contracted in urinating or defecating to prevent urination and defecation [16]. This method can be done while sitting, lying down, and even standing. In Kegel exercise, we should first identify the pelvic floor muscles by trying to stop the urine stream by the muscles during urination. The muscles used to do this are the muscles that should be exercised. After identifying the pelvic floor muscles, empty the bladder, tighten the pelvic floor muscles, hold this contraction for 5 s, and then release and rest for 5 s. This exercise is repeated 4 to 5 times each time. This exercise can be extended to 10 s of contraction and 10 s of rest [17].

Regarding the effect of pelvic floor muscle-strengthening exercises on reducing the severity of lower back pain, several interventional studies have been conducted in different parts of the world on different population [18–21]. Considering the different results obtained from these studies, it seems necessary to conduct a systematic review and meta-analysis study to estimate a pooled effect of the results. Therefore, the present systematic review and meta-analysis aimed to review and summarize the results of RCTs about the effect of pelvic floor muscle-strengthening exercises on reducing low back pain.

Methods

The present systematic review and meta-analysis was conducted based on the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) 2020 protocol (http://www.prisma-statement.org/), including identification, screening, eligibility, and included [22] from 2004 to January 2022.

Identification of studies

A systematic literature review was conducted in the Persian databases of SID (https://www.sid.ir) and MagIran (https://www.magiran.com) and the English databases of Embase, PubMed, Scopus, ClinicalTrials.gov, and Web of Science (Wows) to identify relevant publications. The searches included the combinations of the following MeSH for PubMed/Emtree for Embase and Free Text words: "Pelvic Floor Muscle Exercise," "Pelvic Floor Muscles," "Pelvic Floor Physical Therapy,", "Kegel", "Kegel s", "Hip Strengthening Exercises", "Pelvic Stabilizing Exercise" "Pelvic Floor," "Back Pain," "Pelvic Girdle Pain". No time and language limitation were considered for the search to retrieve as comprehensive as possible related studies. Furthermore, the Google Scholar motor engine was also searched. The references of all included articles and also the studies that cited to the included articles were manually reviewed to maximize the comprehensiveness of the search. For example, the PubMed search strategy was defined as follows:

(((((((("Pelvic Floor Muscle Exercise"[Title/Abstract]) OR ("Pelvic Floor Muscles"[Title/Abstract])) OR ("Pelvic Floor Physical Therapy"[Title/Abstract])) OR (Kegel[Title/Abstract])) OR ("Kegel s"[Title/Abstract])) OR ("Hip Strengthening Exercises"[Title/Abstract])) OR ("Pelvic Stabilizing Exercise"[Title/Abstract])) OR ("Pelvic Floor"[MeSH Terms])) AND ((((("Back Pain"[Title/Abstract]) OR ("Pelvic Girdle Pain"[Title/Abstract])) OR ("Back Pain"[MeSH Terms])) OR ("Pelvic Girdle Pain"[MeSH Terms])).

Inclusion criteria

The inclusion criteria were original scientific-research articles, randomized clinical trial (RCT) (the control group received routine lower back pain treatments, and the intervention group received routine lower back pain treatments and pelvic floor muscle strengthening exercises), access to the full text of the article, studies which examined the effect of pelvic floor muscle-strengthening exercises on reducing the lower back pain intensity, and studies with adequate data (reporting Mean ± SD of lower back pain intensity before and after intervention in both intervention and control groups).

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, animal studies, duplicate studies, lack of access to the full text of the articles, lack of sufficient data (failure to report mean ± SD of low back pain intensity before and after intervention in both case and control groups), and lack of control group.

Selection process of studies

All articles obtained from various databases were imported into EndNote X8 software. After eliminating the duplicates, the title and abstract of the studies were thoroughly screened to excluded the irrelevant studies by two authors (M.R and M.K) separately. The full text of remaining articles was carefully assessed (by M.R and M.K) to remove the studies which unmet the inclusion criteria. Researchers extracted the articles without knowing the name of authors, institutes, and journals. Finally, the quality assessment of all studies included for systematic review and meta-analysis was done.

Study quality assessment

The study quality assessment was done using the Joanna Briggs Institute (JBI) checklist for randomized controlled trials (RCT) [23]. This checklist comprises of 13 different items, including randomization, allocation concealment, similarity of treatment groups at baseline, blindness of the participants, blindness of doers, blindness of the evaluators of the results, similar treatment in groups except intervention, follow-up, participant analysis, outcomes, reliability of the method of measuring results, appropriate statistical analysis, and appropriate trial design. The responses of "Yes" for pointed, "No" for not pointed, and "Not applicable" for not reported are used for scoring. The total score range based on the number of "Yes" is between 0 and 13.

Data extraction

The data were manually extracted from all final articles included in the systematic review and meta-analysis using a pre-prepared checklist. The items of this checklist included first author, year of publication, country, age, sample size, mean ± SD of lower back pain intensity before and after intervention in both case and control groups, *P* value, type of intervention, study design, and diagnostic tool. All steps of identification, selection, and study quality assessment as well as data extraction were done by two researchers (M.R and M.K) independently to reduce bias. If necessary, the third researcher (F.R) was consulted on resolving any conflict or disagreement between the two researchers.

Statistical analysis

The present study reviewed the effect of pelvic floor muscle-strengthening exercises on reducing the severity of lower back pain. Mean and standard deviation (SD) before and after the intervention in both intervention and control groups were used to combine the results of different studies. We estimated the differences between means by standardized difference in means (SMD). Heterogeneity among studies was evaluated using I^2 statistic, and random effects model was used, due to the high heterogeneity between the results of studies included in the meta-analysis (I^2>75%). The parameter changes between the studies were calculated in the random effect model. Thus, the results of random effects model in heterogeneous conditions are more generalizable than those of fixed effect model. I^2 < 25% is considered for "low heterogeneity," I^2 between 25 and 75% for "moderate heterogeneity" and I^2 > 75% for "high heterogeneity". Funnel plot and Egger's regression intercept were used to assess the publication bias. Sensitivity analysis was performed for evaluation of the effect of the included studies on the overall effect by excluding studies in turn and then considering the most dominant effects. Furthermore, the meta-regression was used to investigate the relationship between SMD of low back pain intensity before and after the intervention in the intervention and control groups and the year of publication, sample size, participants' mean age, quality assessment score, and number of intervention weeks. The Comprehensive Meta-Analysis software (CMA) (version 2) was used for meta-analysis. *P*-value < 0.05 was considered as statistically significant.

Results

The summary of how studies included in the meta-analysis

The systematic literature search in different databases retrieved 670 articles. After excluding 315 duplicates and studies with overlapping data, 307 irrelevant studies were removed by screening the title and abstract. Then, full text of the remaining 48 studies were inspected carefully, and 29 articles were eliminated due to not fulfilling the eligibility criteria. Finally, 19 articles met inclusion criteria were included in the meta-analysis. Figure 1 displays the PRISMA 2020 flow diagram.

General characteristics of the studies

The total sample size of all articles included in the study was 456 in the intervention group and 470 in the control

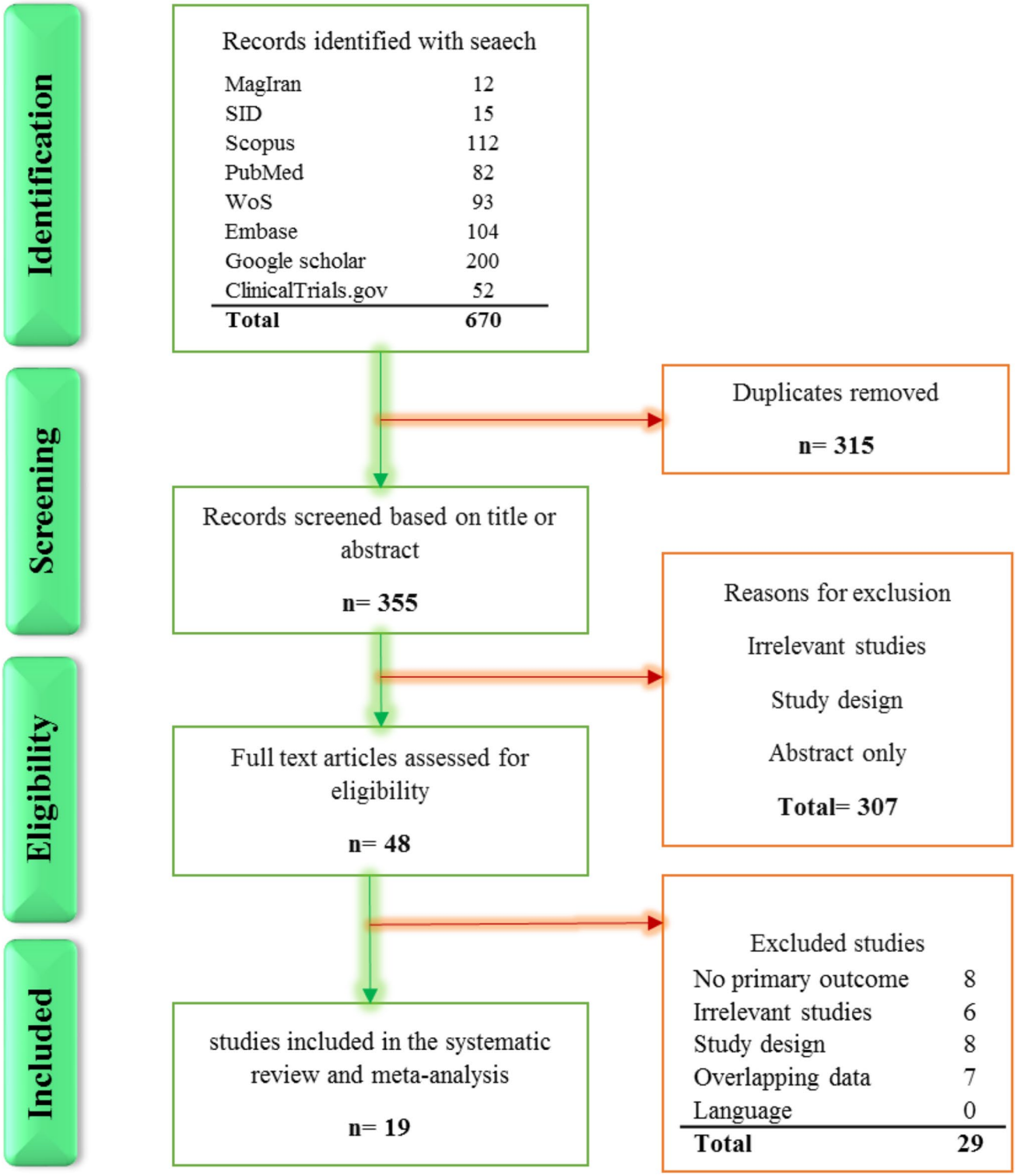

Fig. 1 PRISMA 2020 flow diagram for article selection

group. The oldest study was conducted in 2004 and the most recent study in 2020. The highest number of studies ($n = 7$) was conducted in Iran. The diagnostic tool of lower back pain in most studies (16 articles) was visual analogue scale (VAS). The study sample size was between 17 and 86 subjects. The lowest time of intervention was related to the Kendall's study et. al study (2015) [37] with 1-week intervention. The highest frequency

of the exercise was related to Mohammad's et. al study (2011) [24], with six sessions per day. The Dsingh and Kaur's study (2019) [35] employed the most duration of exercise for each session (i.e., half an hour). The quality assessment score of studies based on the JBI checklist was reported between 8 and 12. Table 1 indicates the characteristics and data of studies included in the systematic review and meta-analysis.

Meta-analysis of standardized mean difference before and after pelvic floor muscle-strengthening exercises in the intervention and control groups

Based on the results of the present meta-analysis and given the high heterogeneity among included studies ($I^2 = 87.60$), the random effects model was employed to combine the effect size of the studies. As a result of the combination of studies, the score of lower back pain in the intervention group demonstrated a statistically significant decrease of 1.261 ± 0.213 (SMD ± 95% CI) more than that in the control group ($P<0.001$). The forest plot indicates SMD ± 95% CI of each study and the pooled SMD ± 95% CI of all included studies (Fig. 2). In the present study, the largest difference between the SMD of low back pain in the control and intervention groups among all included study was 3.687 ± 0.798. Based on the Egger's regression intercept, there was no publication bias in the studies ($P>0.001$) verified by visual inspection of the funnel plot (Fig. 3). The results of sensitivity analysis illustrated that the pooled estimation does not change significantly with the elimination of any of the studies (Fig. 4).

Meta-regression

We conducted meta-regression to explain study differences in pelvic floor exercise effects in terms of study covariates. The relationship between the potential factors, such as year of the publication (Fig. 5), sample size (Fig. 6), mean age (Fig. 7), number of the weeks of intervention (Fig. 8), and quality assessment score of JBI checklist (Fig. 9) and SMD before and after pelvic floor muscle-strengthening exercises in the intervention and control groups was examined using meta-regression. The results showed that the effect of the intervention significantly reduced by increasing sample size ($P<0.05$) (Fig. 6). Furthermore, the effect of the intervention significantly increased by increasing the year of the publication, the quality assessment score of the article based on the JBI checklist, and the number of intervention weeks ($P<0.05$) (Figs. 5, 8, and 9). The relationship between patients' age and the effect of the intervention was not significant ($P>0.05$) (Fig. 7).

Subgroup analysis

Due to the high heterogeneity of the studies, subgroup analysis was used according to three categories of the study population including patients with low back pain, postpartum women, and pregnant women. The highest decrease in the intensity of low back pain score was obtained 1.614 ± 0.312 (SMD ± 95% CI) with $I^2 = 84.69\%$ in the intervention group compared to the control group in postpartum women. However, heterogeneity remained in the high level among all three subgroups, ranged from 83.97 to 89.49 (Table 2).

Discussion

The present study aimed to determine the effect of pelvic floor muscle-strengthening exercises on reducing the lower back pain intensity using systematic review and meta-analysis on RCTs. After combining the data from 19 articles, lower back pain intensity following pelvic floor muscle-strengthening exercises significantly decreased in the intervention group more than that in the control group, indicating the positive effect of using these exercises on reducing the lower back pain intensity.

Various systematic review or meta-analysis studies reported the positive effect of pelvic floor muscle-strengthening exercises on pelvic organ prolapse [39], urinary incontinence and patients' quality of life [40], prevention of urinary incontinence during pregnancy [41], childbirth results [42], real stress incontinence in women [43], sexual function and postpartum quality of life [44], diastasis recti abdominis postpartum [45], and lumbopelvic pain [46].

de Jesus et al. (2020) in a meta-analysis reported that hip-strengthening exercises improve lower back pain (MD: − 5.4 mm, 95% CI: − 8.9 to − 1.8 mm) [47], which is consistent with the results of the present study. The slight difference between the results of the present study and aforementioned study is due to the number of articles included in the meta-analysis (5 articles in the study of de Jesus et al. versus 19 articles in the present study), sample size (309 subjects in the study of de Jesus et al. versus 926 subjects in the present study), and period (studies conducted between 2015 and 2017 in the study de Jesus et al. versus 2004–2022 in the present study). Of the five articles included in the study by De Jesus et al., four articles included the hip joint strengthening along with other interventions, and only one study examined the effect of the hip joint strengthening alone. In all the studies in the present study, the control group received routine exercises, and the intervention group received routine exercises plus pelvic floor muscle-strengthening exercises. While in the present meta-analysis, there are seven articles included patients with low back pain, seven studies included postpartum women, three studies included pregnant women, one study included patients with cystocele, and one study conducted on women who

Table 1 The characteristics and data of studies included in the systematic review and the meta-analysis

First author, year, (reference)	Place of study	Age (year) intervention group	Sample size (*n*)		Mean ± SD control group			Mean ± SD intervention group			Type of study	Diagnostic tool	Quality score (number "yes")	Type of intervention	Population
			Intervention group	Control group	Before	After	*P* value	Before	After	*P* value					
Mohammad, 2011 [24]	Iran	34.71 ± 5.03	10	10	5.79 ± 1.2	2.35 ± 0.8	0.000	5.96 ± 0.9	2.41 ± 1	0.000	Randomized clinical trial	VAS	9	6 sessions per day for 3 months (each session 4 contractions of 5 s and 4 s rest between each contraction)	Patients with lower back pain
Bi, 2013 [18]	China	29.08 ± 2.68	24	23	5.22 ± 2.64	2.97 ± 2.27	0.045	5.35 ± 3.57	2.08 ± 1.63	0.034	Randomized clinical trial	VAS	10	The pelvic floor muscle exercise programme was based on contraction of the pelvic floor muscles for 6 s followed by rest for 6 s, resulting in 5 contraction cycles/min. The number of contraction cycles was increased over the 24-week treatment period: week 1, 25 cycles/day (5 min total); week 2, 50 cycles/day (10 min total); week 3, 75 cycles/day (15 min total); weeks 4–24, 100 cycles/day (20 min total)	Patients with lower back pain
Ghaderi, 2016 [25]	Iran	53.2 ± 1.1	30	30	6.91 ± 0.32	2.96 ± 0.17	0.000	6.75 ± 0.33	2.17 ± 0.18	0.000	Randomized clinical trial	VAS	11	3 sessions per week (20 min each session) for 9 weeks	Patients with lower back pain
Goldfinger, 2009 [26]	Canada	23 (19–31)	11	11	6.73 ± 1.85	2.23 ± 1.31	< 0.001	6.77 ± 1.93	2.14 ± 1.8	< 0.001	Randomized clinical trial	VAS	8	3 sessions per week (5–12 min each session) for 13 weeks	Patients with lower back pain
Kluge, 2011 [27]	South Africa	27 (20–32)	24	26	3.1 ± 1.6	3.3 ± 1.25	0.89	3.0 ± 1.2	1.85 ± 1.0	< 0.01	Unblended randomized controlled trial	Likert-modified Roland–Morris Disability Questionnaire	11	3 sessions per week (20 min each session) for 10 weeks	Pregnant women
Naqaish, 2013 [28]	Pakistan	> 20	25	25	1.30 ± 0.78	1.28 ± 0.61	-	1.33 ± 0.52	1.08 ± 0.28	-	Randomized clinical trial	VAS	8	Three times a day for 5 min each time for 4 months	Patients of cystocele
Stuge, 2004 [29]	Norway	33 ± 3.7	31	34	3.6 ± 1.6	2.0 ± 1.5	-	3.9 ± 2.1	0.1 ± 0.06	-	Randomized clinical trial	VAS	11	Three times a day for 5 min each time for 1 year	Postpartum women
Gutke, 2010 [30]	Sweden	32 ± 4	54	32	3.5 ± 1.2	2.1 ± 1.8	< 0.05	3.6 ± 1.3	1.5 ± 1.7	< 0.001	A prospective, randomized, single-blinded, clinically controlled study	VAS	8	Twice a day and each series with ten repetitions for 3 months	Postpartum women

Table 1 (continued)

First author, year, (reference)	Place of study	Age (year) intervention group	Sample size (*n*)		Mean ± SD control group			Mean ± SD intervention group			Type of study	Diagnostic tool	Quality score (number "yes")	Type of intervention	Population
			Intervention group	Control group	Before	After	*P* value	Before	After	*P* value					
Kordi, 2013 [31]	Iran	26.45 ± 5.35	35	31	5.1 ± 1.38	4.42 ± 1.33	-	5.82 ± 1.4	4.43 ± 1.48	< 0.001	Randomized clinical trial	VAS	9	25 min a day, three times a week for 3 months	Pregnant women
Teymuri, 2018 [32]	Iran	33.55 ± 6.86	18	18	8.27 ± 1.7	4.27 ± 2.21	0.001	7.44 ± 1.85	1.16 ± 1.24	0.001	Single-blind, randomized controlled trial	VAS	10	Three times a week and each session for 20 min for 6 weeks	Postpartum women
Ramezanpour and Akhlaghi, 2018 [33]	Iran	26.73 ± 2.76	15	15	4.6 ± 0.99	5.9 ± 0.7	0.0001	4.8 ± 1.08	4.4 ± 0.74	0.138	Randomized clinical trial	VAS	11	Twice a day for 15–20 min and each time 15–20 times for 12 weeks	Pregnant women
Kumar, 2015 [34]	India	20–35	15	15	6.2 ± 1.2	6.1 ± 1.3	-	4.5 ± 0.7	2.3 ± 0.8	-	Randomized clinical trial	NPRS	11	Three times a week and each session for 20 min for 6 weeks	Postpartum women
Dsingh and Kaur, 2019 [35]	India	-	9	8	7.4 ± 0.882	6.15 ± 1.089	-	7.3 ± 0.801	2.7 ± 0.66	-	Randomized clinical trial	VAS	11	For half an hour a day, three times a week for 5 weeks	Women with sitting Jobs
ElDeeb, 2019 [20]	Egypt	29.25 ± 2.88	20	20	7.15 ± 0.93	5.55 ± 0.69	0.001	7.45 ± 1	3.15 ± 1.14	0.001	Double-blinded, randomized controlled trial	VAS	12	10–20 repetitions per set for three sets per week for 12 weeks	Postpartum women
Ehsani, 2020 [19]	Iran	28.74 ± 4.53	33	35	6.74 ± 1.63	6.51 ± 1.7	-	5.91 ± 1.80	2.45 ± 1.99	-	Double-blinded, randomized controlled trial	VAS	9	10 repetitions in each session of 15–20 min three times a week	Postpartum women
Khorasani, 2020 [21]	Iran	30.75 ± 5.09	27	28	6.44 ± 2.35	6.55 ± 2.37	-	6.60 ± 2.37	4.00 ± 1.96	-	Single-blind, randomized controlled trial	VAS	10	3 days a week, three sessions a day for 12 weeks	Postpartum women
Bade, 2017 [36]	USA	44.8 ± 2.3	39	45	2.9 ± 1.6	1.9 ± 1.6	-	2.7 ± 1.5	1.1 ± 1.1	-	Randomized clinical trial	VAS	9	3 days a week, three sessions a day for 3 weeks	Patients with lower back pain
Kendall, 2015 [37]	Canada	41 (37–45)	40	40	5.7 ± 2.3	3.7 ± 1.5	-	5.5 ± 1.7	3.0 ± 2.4	-	Single-blind, randomized controlled trial	VAS	8	One session a day for 15–20 min for 1 week	Patients with lower back pain
Winter, 2015 [38]	Australia	48.9 ± 7.2	10	10	7.4 ± 1.8	4.5 ± 2.1	< 0.05	7.3 ± 2.0	3.3 ± 1.7	< 0.05	Randomized clinical trial	NPRS	9	One session a day for 15–20 min for three months	Patients with lower back pain

had sitting jobs; the population studied in the De Jesus's study were people who suffered from lower back pain. The study of De Jesus et al. did not report any information about the number of intervention sessions, the duration and frequency of the intervention, participants mean age, and the way of the exercises. In the present meta-analysis, meta-regression was performed according to the year of the publication, number of weeks of intervention, and the participants mean age, sample size, and quality of the study.

The pelvic floor consists of 12 striated muscles that are in three layers. This muscle plate extends from the pubic symphysis to the walls of the ileum and coccyx. The weakness of these muscles leads to prolapse of the pelvic organs, lower back pain, and urinary incontinence [48]. Pelvic floor muscle weakness has a variety of pharmacological, surgical, and behavioral therapies. The behavioral therapies with the ability to correct and improve the disease and the ability to learn are often recommended [49]. Pelvic floor exercises as a conservative treatment are usually considered as the first line of treatment, stabilizing the structure and function, and balancing the passive, active, and neural performance of the pelvic floor muscle complex [50, 51]. Physiotherapists recommend performing this exercise three to four times a week, each time with three continuous contractions, including eight to ten continuous contractions [52]. There is no positive attitude towards Kegel exercises for reasons, such as the lack of awareness of the benefits and uses of these exercises. In addition, health education evaluation is not generally performed in this case, which limits its efficiency and effectiveness [53, 54]. Therefore, it is necessary to provide a suitable educational program or model according to health education and health promotion theories. Choosing an educational model leads to starting the program and continuing it in the proper direction to achieve a desirable outcome [55, 56].

The effect of pelvic floor muscle-strengthening exercises has not always been positive and significant. In reviewing the systematic review and meta-analysis studies, it has been reported that the effect of these exercises on post-prostatectomy urinary incontinence [57, 58] and treatment of postpartum urinary incontinence [41] is not significant.

The meta-regression analyses showed that it has been obtained a more effective results from the educational intervention of pelvic floor exercise in recent years. It may be related to having more accessibility of the further educational materials from several channels such as media, M-health, and social networks in the recent decay. We also observed the more effective results in the studies that they had smaller sample size. We have a rage of sample size from 8 to 45 in the intervention groups. The quality of the educational sessions for the exercise may be affected by increasing the number of the participants. Studies that included more weeks of the pelvic floor muscle-strengthening exercise intervention found better effects in reducing back pain than that studies had a shorter time intervention. The most robust methodology based on the JBI checklist (score = 12) was related to the study of ElDeeb et al. (2019) [20], which showed that pelvic floor muscle-strengthening exercises significantly reduce lower back pain severity. This is not unexpected as the results of meta-regression (Fig. 9) indicated that the positive effect of these exercises on reducing the severity of lower back pain enhances by increasing the quality assessment score of studies.

In the vaginal postpartum period, injuries inflicted during fetal passage or episiotomy during the ejaculatory phase reduce pelvic floor muscle strength after delivery. Still, the pelvic floor muscles strength of most of the women returns to the original state 2-month postpartum [59]. Doing Kegel exercises helps to increase blood flow of the pelvic muscles and accelerates wound healing in the postpartum period [19, 21]. The results of subgroup analysis by the type of study population showed that the Kegel exercises on reducing lower back pain in the patients who had low back pain, postpartum women, and pregnant women are effective. Considering the larger pooled SMD in the postpartum group, it may be interpreted that these exercises are more effective in the postpartum women than other subgroups, but due to the high heterogeneity after subgroup analysis, this result should be interpreted with caution. Furthermore, remaining high heterogeneity after subgroup analysis suggests that the type of the population educated by pelvic floor muscle-strengthening exercise was not the source of the heterogeneity. Therefore, the potentially influential factors on the heterogeneity of the included studies were not captured by this subgroup analysis. However, a meta-anlysis proved the pelvic floor muscle training improve the sexual function and quality of life in postpartum women [44].

However, given that the Kegel exercises are easy to do and have positive effects on postpartum, it is recommended that postpartum women do these exercises in their daily activity.

According to the results of the present systematic review and meta-analysis, pelvic floor muscle-strengthening exercises effectively reduce lower back pain severity. Also, the results of reviewing included studies demonstrated the positive effects of these exercises on pelvic organ prolapse, urinary incontinence, quality of life, real stress incontinence in women, sexual function, etc. Therefore, it is recommended to consider the necessary plans to train pelvic floor muscle-strengthening exercises, especially during pregnancy and postpartum, and encourage and justify them to do these exercises.

Study name	Std diff in means	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
Mohammad, 2011	0.121	0.448	0.200	-0.756	0.999	0.271	0.786
Bi, 2013	0.514	0.297	0.088	-0.067	1.096	1.734	0.083
Ghaderi, 2016	3.599	0.418	0.175	2.780	4.417	8.613	0.000
Goldfinger, 2009	0.083	0.427	0.182	-0.754	0.919	0.194	0.846
Kluge, 2011	1.198	0.307	0.094	0.596	1.801	3.898	0.000
Naqaish, 2013	0.485	0.287	0.082	-0.078	1.047	1.689	0.091
Stuge, 2004	2.124	0.310	0.096	1.515	2.732	6.841	0.000
Gutke, 2010	0.397	0.225	0.051	-0.044	0.838	1.763	0.078
Kordi, 2013	0.506	0.251	0.063	0.015	0.997	2.021	0.043
Teymuri, 2018	1.272	0.366	0.134	0.556	1.989	3.481	0.000
Ramezanpour and Akhlaghi, 2018	2.360	0.476	0.226	1.428	3.292	4.963	0.000
Kumar, 2015	1.946	0.443	0.196	1.077	2.814	4.390	0.000
Dsingh and Kaur, 2019	3.687	0.798	0.636	2.124	5.251	4.624	0.000
ElDeeb, 2019	2.865	0.450	0.203	1.983	3.748	6.366	0.000
Ehsani, 2020	1.741	0.285	0.081	1.183	2.300	6.112	0.000
Khorasani, 2020	1.248	0.295	0.087	0.671	1.826	4.234	0.000
Bade, 2017	0.443	0.221	0.049	0.009	0.877	2.000	0.046
Kendall, 2015	0.250	0.224	0.050	-0.190	0.690	1.113	0.266
Winter, 2015	0.576	0.456	0.208	-0.319	1.470	1.262	0.207
	1.261	0.213	0.045	0.843	1.679	5.915	0.000

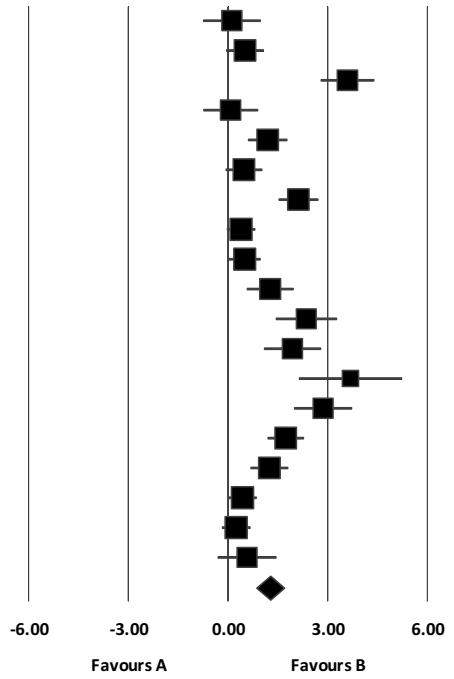

Fig. 2 The forest plot of studies included in the meta-analysis before and after the intervention in the control and intervention groups

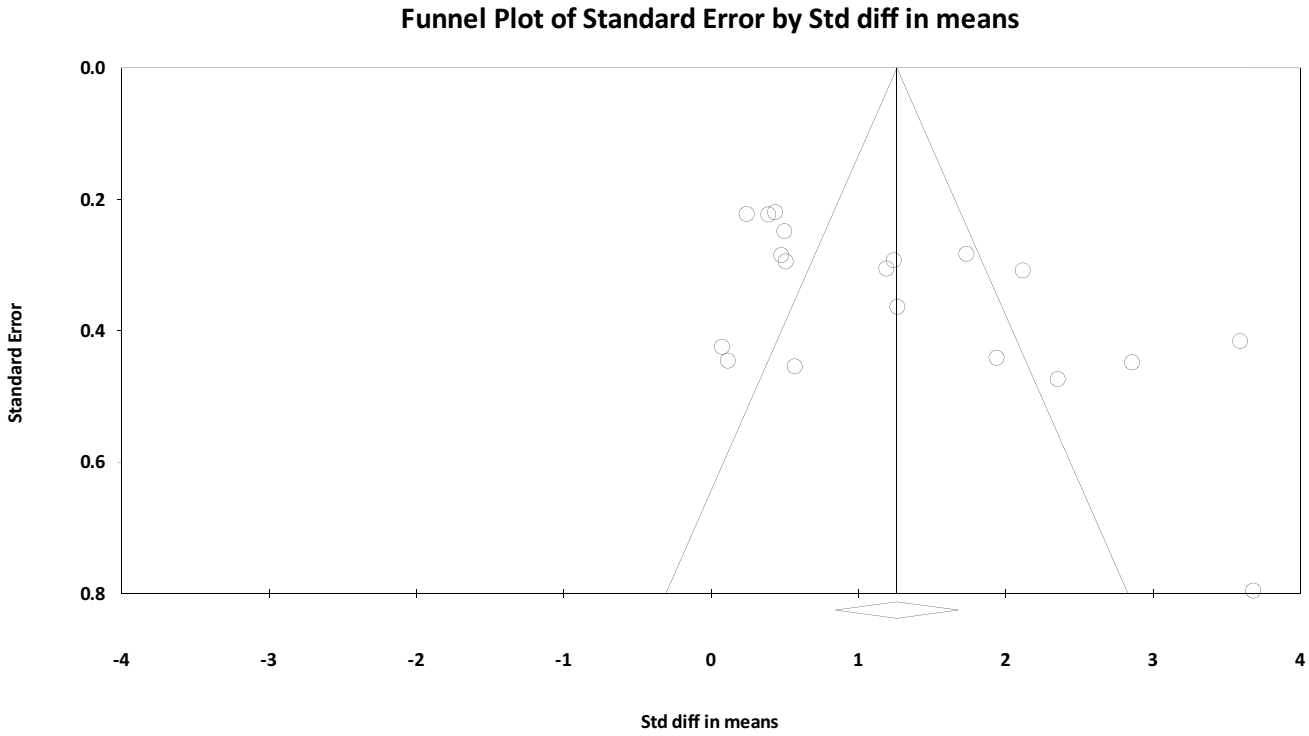

Fig. 3 The funnel plot of studies included in the meta-analysis before and after the intervention in the control and intervention groups

Study name	Point	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
Mohammad, 2011	1.320	0.219	0.048	0.890	1.750	6.020	0.000
Bi, 2013	1.308	0.224	0.050	0.868	1.748	5.826	0.000
Ghaderi, 2016	1.119	0.190	0.036	0.746	1.492	5.881	0.000
Goldfinger, 2009	1.323	0.219	0.048	0.894	1.753	6.040	0.000
Kluge, 2011	1.268	0.226	0.051	0.826	1.711	5.619	0.000
Naqaish, 2013	1.310	0.225	0.050	0.870	1.750	5.835	0.000
Stuge, 2004	1.208	0.215	0.046	0.786	1.629	5.618	0.000
Gutke, 2010	1.318	0.225	0.051	0.876	1.759	5.846	0.000
Kordi, 2013	1.311	0.226	0.051	0.867	1.754	5.795	0.000
Teymuri, 2018	1.263	0.224	0.050	0.825	1.701	5.649	0.000
Ramezanpour and Akhlaghi, 2018	1.204	0.215	0.046	0.782	1.626	5.593	0.000
Kumar, 2015	1.225	0.219	0.048	0.797	1.654	5.604	0.000
Dsingh and Kaur, 2019	1.175	0.210	0.044	0.764	1.586	5.601	0.000
ElDeeb, 2019	1.173	0.208	0.043	0.764	1.581	5.626	0.000
Ehsani, 2020	1.233	0.221	0.049	0.799	1.667	5.571	0.000
Khorasani, 2020	1.265	0.226	0.051	0.822	1.708	5.599	0.000
Bade, 2017	1.315	0.226	0.051	0.872	1.759	5.809	0.000
Kendall, 2015	1.325	0.222	0.049	0.890	1.760	5.971	0.000
Winter, 2015	1.298	0.221	0.049	0.864	1.732	5.861	0.000
	1.261	0.213	0.045	0.843	1.679	5.915	0.000

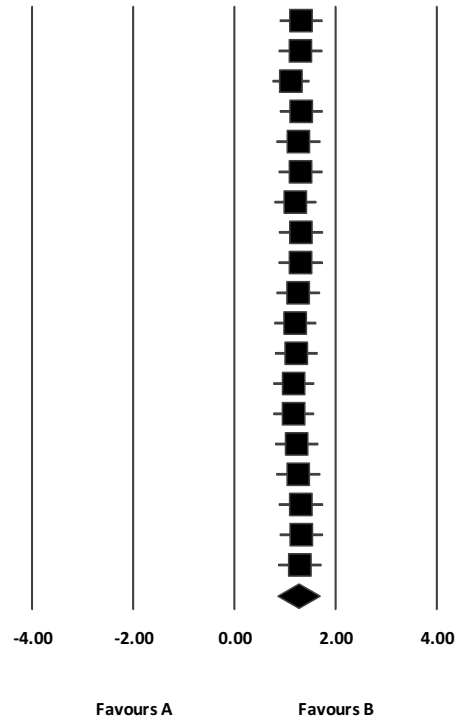

Fig. 4 The sensitivity analysis chart before and after the intervention in the control and intervention groups based on the random effects model

Limitations

Despite the generation of more powerful estimate of true pooled effect size with less random error in the process of systematic literature review and meta-analysis, the results of the present study should be considered with respect to some limitations, including the lack of uniform reporting of articles, non-randomization of samples, non-uniform study design, low sample size for meta-analysis in some subgroup, and unavailability of the full text of articles presented at the conferences. Another limitation of the present study is that the low number of studies

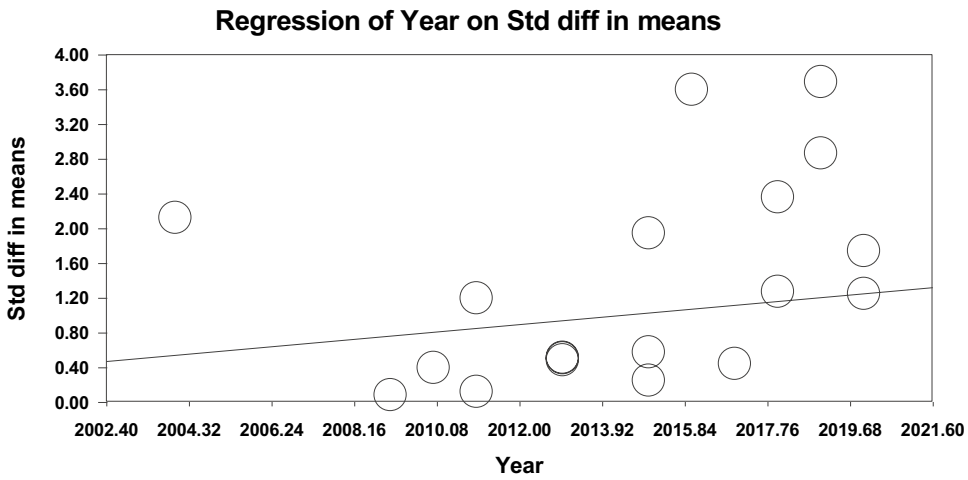

Fig. 5 The meta-regression of the relationship between the year of the publication and the SMD before and after the intervention in the control and intervention groups

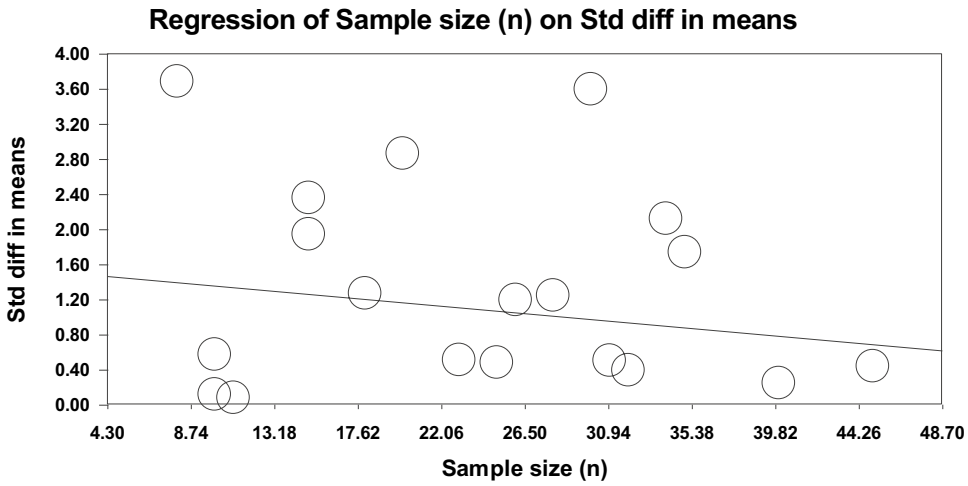

Fig. 6 The meta-regression of the relationship between sample size and SMD before and after intervention in the control and intervention groups

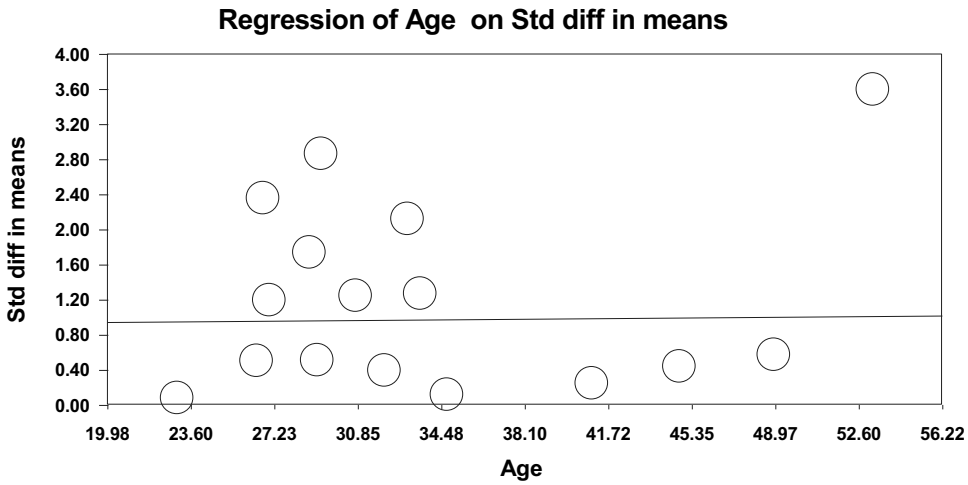

Fig. 7 The meta-regression of the relationship between mean age and SMD before and after intervention in the control and intervention groups

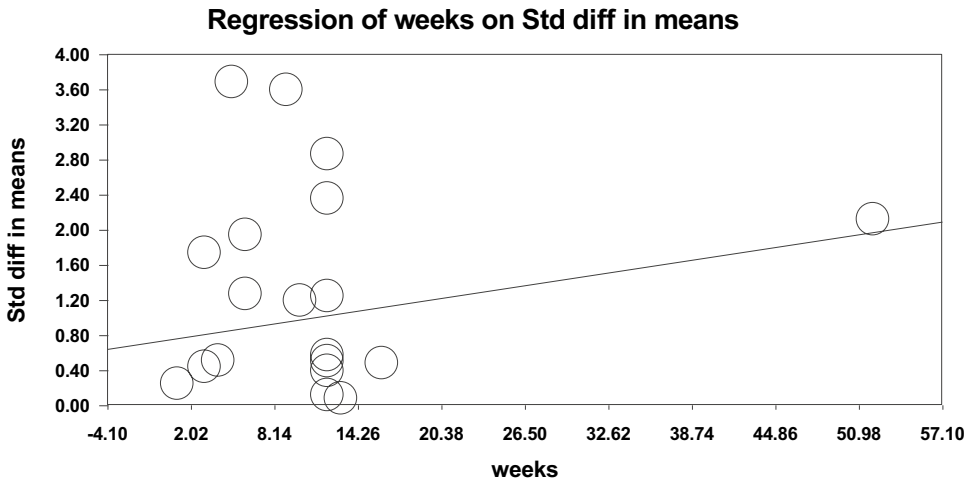

Fig. 8 The meta-regression of the relationship between the mean number of the weeks of intervention and SMD before and after the intervention in the control and intervention groups

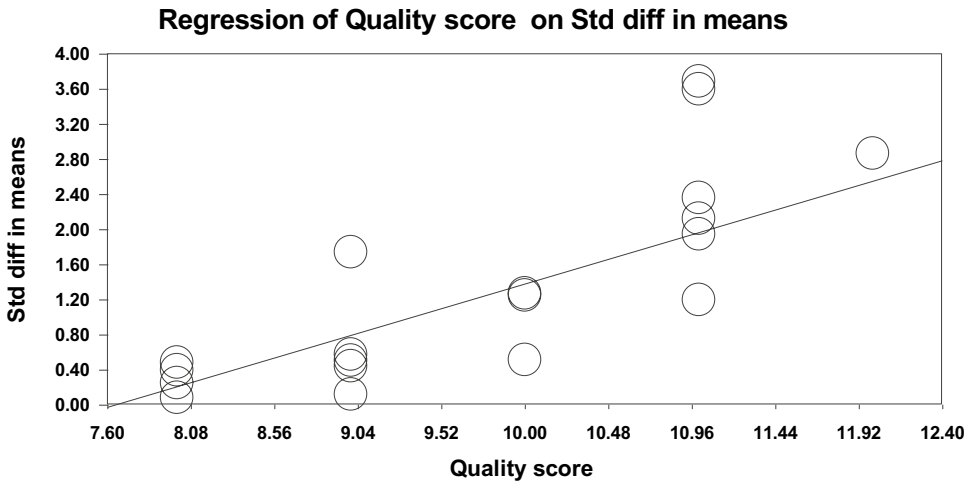

Fig. 9 The meta-regression of the relationship between the quality assessment score of JBI checklist and SMD before and after intervention in the control and intervention groups

Table 2 Subgroup analysis according to patients with lower back pain, postpartum women, and pregnant women

Subgroups	Number of studies	Point estimate	Standard error	*P* value	*Q* value	df (Q)	*P* value between	*I*-squared	Tau
Patients with lower back pain	7	0.782	0.380	0.040	18.691	2	0.001	89.49	0.938
Postpartum women	7	1.614	0.312	0.000				84.69	0.750
Pregnant women	3	1.282	0.479	0.007				83.97	0.753

conducted on the effect of Kegel exercises on some populations, including patients with cystocele and women with sedentary jobs. Therefore, it is suggested to perform further studies in different parts of the world with larger sample size to determine the effect of these exercises on different populations.

Conclusion

The results of the present systematic review and meta-analysis indicated that pelvic floor muscle-strengthening exercises significantly reduce low back pain. Also, its effect has increased in recent years, and the number of intervention weeks has increased. Therefore, it seems that these exercises can be considered as a part of a lower back pain treatment program.

Abbreviations *SID*: Scientific Information Database; *WoS*: Web of Science; *MeSH*: Medical Subject Headings; *JBI*: Joanna Briggs Institute; *PRISMA*: Preferred Reporting Items for Systematic Reviews and Meta-Analysis; *RCT*: Randomized clinical trial; *VAS*: Visual analogue scale; *NPRS*: Numerical Pain Rating Scale

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Author contribution M.K. and F.R. contributed to the design. M.K. and M.R. participated in most of the study steps. M.K. and F.R. prepared the manuscript. M.K. and M.R. assisted in designing the study and helped in the, interpretation of the study. All authors have read and approved the content of the manuscript.

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Data availability Datasets are available through the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate Ethics approval was received from the ethics committee of deputy of research and technology, Kermanshah University of Medical Sciences (IR.KUMS.REC.1400.788).

Consent for publication Not applicable.

Conflict of interest The authors declare no competing interests.

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