Urologia Internationalis

Systematic Review

Urol Int 2025;109:425–435
DOI: 10.1159/000543133

Received: October 29, 2024
Accepted: December 8, 2024
Published online: January 8, 2025

Effect of Pelvic Floor Muscle Training Combined with Electrical Stimulation Therapy on Stress Urinary Incontinence: A Meta-Analysis

Shenghua Li[a] Shengjing Zhang[a] Liangwei Zhao[a] Xiangli Xiong[b]

[a]Department of Urology, Huzhou Traditional Chinese Medicine Hospital Affiliated to Zhejiang Chinese Medical University, Huzhou, China; [b]Department of Gynecology, International Branch of the First People's Hospital of Huzhou City, Zhebei Mingzhou Hospital, Huzhou, China

Keywords

Stress urinary incontinence · Pelvic floor muscle training · Electrical stimulation · Combined therapy · Meta-analysis · Quality of life

Abstract

Introduction: SUI is a common pelvic floor dysfunction in middle-aged and elderly women, which has a serious negative impact on the patient's quality of life (QoL); pelvic floor muscle training (PFMT) and electrical stimulation (ES), as common non-surgical treatment modalities, have been widely used in the management of SUI. However, there is controversy about the effectiveness of the combined application of these two interventions. For this reason, this study evaluated the efficacy of PFMT combined with ES in the treatment of SUI by meta-analysis. To systematically evaluate the efficacy of PFMT combined with ES in improving urinary incontinence symptoms, increasing pelvic floor muscle strength, enhancing QoL, and improving clinical symptoms, with the aim of providing more adequate evidence to support clinical treatment. ***Methods:*** A literature search was conducted in PubMed, Embase, Web of Science, and Cochrane Library databases from database construction to October 2024 to include RCTs and case-control studies evaluating PFMT combined with ES for the treatment of SUI. The Cochrane Risk Assessment Tool and NOS were used to assess the quality of the included literature, and effect sizes were calculated by random-effects model and fixed-effects model, and the main outcome indicators included incontinence symptoms, pelvic floor muscle strength, QoL, and clinical symptoms. ***Results:*** Eight studies were ultimately included, with a total sample size of 885 cases. Meta-analysis showed that PFMT combined with ES was significantly better than the control group on all outcome measures. The combined effect size for improvement in urinary incontinence symptoms was OR = 1.42 (95% CI: 1.10, 1.85, $p < 0.05$), the combined effect size for pelvic floor muscle strength was OR = 1.55 (95% CI: 1.20, 2.05, $p < 0.01$), the combined effect size for QoL improvement was OR = 4.29 (95% CI: 3.68, 4.99, $p < 0.0001$), and the combined effect size for clinical symptom improvement was OR = 1.35 (95% CI: 1.05, 1.70, $p < 0.05$). Heterogeneity between studies was low (I^2 values were less than 40%), indicating a high degree of consistency in the effect of the combination treatment. ***Conclusion:*** PFMT combined with ES showed significant benefits in improving incontinence symptoms, enhancing pelvic floor muscle strength, boosting QoL, and improving clinical symptoms. Future studies should further standardize the intervention parameters and extend the follow-up period to fully assess the long-term effects of the combined treatment.

karger@karger.com
www.karger.com/uin

Correspondence to:
Xiangli Xiong, 13867258223@163.com

Introduction

Stress Urinary Incontinence (SUI) is a common urinary dysfunction characterized by involuntary leakage of urine in response to coughing, sneezing, exercise, or other increased abdominal pressure [1, 2]. The pathogenesis of SUI is closely related to impaired pelvic floor support structures, bladder and urethral control, and its prevalence is high in adult females, especially in the postpartum, menopausal, and elderly female populations [3]. According to statistics, about 30%–50% of women worldwide will experience varying degrees of SUI during their lifetime [4]. As urinary incontinence seriously affects patients' daily life, work, and social activities, many of them suffer from psychological problems such as embarrassment, anxiety, and even depression as a result, which significantly reduces their quality of life (QoL). Although SUI is more common in women, men, especially after undergoing prostate surgery, may also present with similar incontinence symptoms. The etiology of SUI in men is related to urethral sphincter dysfunction due to surgical or neurological injury [5–7], and therefore, interventions such as pelvic floor muscle training (PFMT) and electrical stimulation (ES) are equally applicable in the treatment of some male patients. Among conservative treatments, PFMT is considered to be the treatment of choice for SUI [8]. The main purpose of PFMT is to enhance the supportive capacity of the pelvic floor tissues through the patient's voluntary contraction and exercise of the pelvic floor muscle groups, which in turn improves the urethra's closure pressure and control and reduces the incidence of urinary incontinence [9]. Several clinical studies have confirmed the significant efficacy of PFMT in improving the symptoms of patients with mild to moderate SUI [10–12]. However, the efficacy of PFMT is highly dependent on the patient's compliance, training skills, and ability to persist over time. As some patients have difficulty in accurately perceiving and controlling the contraction movements of the pelvic floor muscles, or lack sufficient motivation to continue training, the actual efficacy may not meet expectations [13]. To make up for the shortcomings in PFMT treatment, ES has gradually become another important conservative therapy for SUI treatment. ES acts on the pelvic floor neuromuscular system through low-frequency pulsed currents to induce passive contraction of the muscles, which promotes the restoration and enhancement of muscle function. ES is particularly suitable for those patients who are unable to independently control their pelvic floor muscles, who are weak in muscle strength, or who lack the ability to actively exercise [14, 15]. However, although ES can improve SUI symptoms to some extent, the efficacy of ES alone is usually limited, especially when stronger muscle control and long-term maintenance of the therapeutic effect are required.

Based on the respective therapeutic advantages of PFMT and ES, more and more researchers have begun to explore the effects of their combined application in recent years [15–18]. The theoretical basis of the combined treatment is that ES can enhance muscle responsiveness through passive stimulation and help patients establish early pelvic floor muscle function, while PFMT further improves muscle strength and endurance through active contraction training, thus creating a synergistic effect that enhances the overall therapeutic effect [16]. Especially for patients with moderate-to-severe SUI or those who do not respond well to monotherapy, combination therapy is expected to provide more comprehensive and long-lasting symptomatic improvement. Despite the significant theoretical advantages of the combination of PFMT and ES, the evidence on its actual clinical effects remains insufficient and there is some variation in the results across studies. Therefore, it is necessary to comprehensively assess the efficacy and safety of combination therapy versus monotherapy in reducing incontinence frequency, improving urine leakage, enhancing QoL, and strengthening pelvic floor muscles through systematic review and meta-analysis by integrating the data from existing randomized controlled trials (RCTs). This will provide a more solid evidence-based basis for the clinical treatment of SUI and help physicians to develop more optimal treatment strategies.

Methods

Literature Search Strategy

Literature searches were conducted in PubMed, Embase, Web of Science, and Cochrane Library databases, and the literature search was conducted from the time of the construction of each database to October 2024 to ensure that the study covered the latest clinical studies and data. The search strategy combined subject terms (MeSH Terms) and free terms to maximize the accuracy and comprehensiveness of the search. Key search terms included, but were not limited to, "Stress Urinary Incontinence," "Pelvic Floor Muscle Training," Electrical Stimulation," "Randomized Controlled Trial." During the search, keyword combinations were performed using Boolean logical operators (AND, OR, NOT), e.g., ("Stress Urinary Incontinence" OR "SUI") AND ("Pelvic Floor Muscle Training" OR "PFMT") AND ("Electrical Stimulation" OR "ES").

Inclusion and Exclusion Criteria

Inclusion criteria included (1) the study was conducted in patients with a definite diagnosis of SUI, regardless of age, disease duration, or etiology; (2) the intervention was a study of PFMT combined with ES treatment; (3) the control group could be those who received PFMT alone, ES alone, or no intervention; (4) the primary outcome indicators included incontinence symptoms, pelvic floor muscular strength, QoL, and clinical symptoms (ICIQ-SF score); and (5) study results provided sufficient data for meta-analysis.

Exclusion criteria included (1) non-RCTs, cohort studies, case reports, or review articles; (2) patients' comorbidities with other types of incontinence (e.g., urge incontinence or mixed incontinence); (3) failure to provide complete information on the interventions or incomplete data that did not allow for the extraction of key statistical indicators; and (4) too short a follow-up period (less than 3 months) or low quality of the study. The quality and consistency of the included studies were ensured through strict screening criteria to enhance the reliability of the results.

Data Extraction

Data extraction for this meta-analysis was performed by two independent researchers to ensure the accuracy and consistency of the data. The extraction included the following: (1) basic information of the study, including the name of the first author, the year of publication, the country or region, the type of study design, the sample size, and the duration of follow-up; (2) characteristics of the subjects, including the baseline characteristics such as age, gender, duration of the disease, and the severity of the SUI; (3) interventions, including the specific protocols of the PFMT (frequency of training, intensity, duration, etc.), the ES parameter settings (stimulation frequency, waveform, duration, etc.), as well as the treatment program of the control group; (4) outcome indicators, mainly extracted from the improvement of urinary incontinence symptoms, changes in pelvic floor muscle strength, patients' QoL scores, as well as the occurrence of adverse reactions. If the results provided in the study were incomplete or presented only through graphs and charts, the original authors should be contacted for more data. All extracted data were checked, and any disagreements were resolved through discussion or by asking a third investigator to arbitrate to ensure that the data were accurate for subsequent analysis.

Evaluation of Literature Quality

The quality of the included literature was systematically assessed in this study. For case-control studies, The Newcastle-Ottawa Scale (NOS) was used to score the studies in terms of selectivity, comparability, and exposure assessment. NOS was a widely used quality assessment tool that quantitatively scores each study out of 9 using preset criteria. The selectivity assessment included the definition and selection of cases and controls (maximum 4 points); the comparability assessment considers whether confounders were controlled for (maximum 2 points); and the exposure assessment addresses the accuracy of the information obtained as well as whether blinding was performed (maximum 3 points). All included case-control studies had a total score of 7 or higher, indicating that they were of high quality in terms of sample selection, exposure assessment, and measurement of outcomes. The RCTs were evaluated for quality using the Cochrane Risk of Bias Assessment Tool, which assesses the risk of bias in terms of randomized sequence generation, allocation concealment, blinding, incomplete outcome data, and selective reporting.

Statistical Analysis

In this meta-analysis, statistical analyses were mainly performed by Review Manager (RevMan) 5.4 software. For dichotomous variables (e.g., urinary incontinence cure rate or symptom improvement rate), effect sizes were analyzed together using the relative risk (RR) and its 95% confidence interval (CI); for continuous variables (e.g., pelvic floor muscle strength score, QoL score, etc.), they were analyzed using the mean difference (MD) or standardized mean difference (SMD) and their 95% confidence intervals were used for analysis. The choice of effect sizes was determined based on how the outcome variables were measured in each study. Heterogeneity was assessed by the I^2 statistic, with an I^2 value above 50% suggesting moderate or high heterogeneity. If heterogeneity was low ($I^2 \leq 50\%$), a fixed-effects model was used for combined data analysis; if heterogeneity was high ($I^2 > 50\%$), a random-effects model was used, and potential sources of heterogeneity were further sought by subgroup analysis or sensitivity analysis. For possible publication bias, funnel plots were used for assessment and statistically verified by Egger's test. The significance level was set at $p < 0.05$ with a two-sided test.

Results

Results of Literature Screening

According to the predetermined search strategy, a total of 343 documents were retrieved from PubMed, Embase, Web of Science, and Cochrane Library databases in this

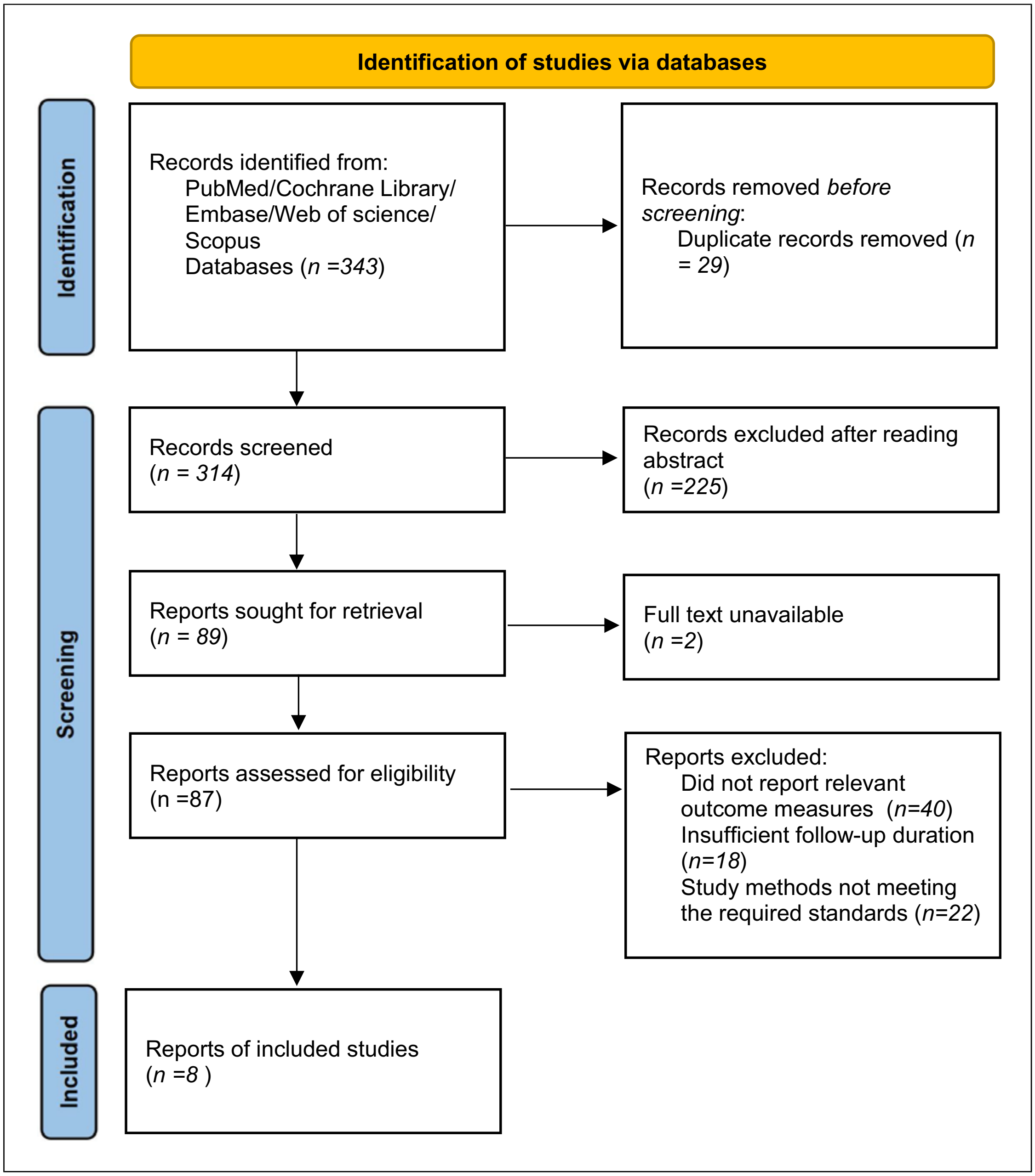

Fig. 1. Schematic diagram of the literature screening process.

study. After removing duplicates, the remaining 314 articles were screened for title and abstract, and 225 articles that did not meet the research objectives were excluded, while the remaining 89 articles were reviewed in full text. After the review, 2 articles were excluded due to unavailability of the full text, and the remaining 79 articles were excluded due to non-reporting of relevant outcome indicators, insufficient follow-up time, or non-compliance with the study methodology. Finally, 8 articles that met the inclusion criteria were included in the meta-analysis. The literature screening process is shown in Figure 1.

Baseline Characteristics and Evaluation of Literature Quality

In this meta-analysis, a total of 8 articles were included, comprising 5 case-control studies and 3 RCTs. The baseline characteristics of the studies are shown in

Table 1. General information of the included literature

Author	Study design	Sample size	Male/female ratio, %	Mean age (range)	Intervention	Duration of follow-up	Main outcome indicators
Dannecker et al. [11] (2005)	Case-control	N = 120	0/100	45 years (35–60 years)	PFMT + EMG biofeedback	7 years	Incontinence symptoms, QoL, pelvic floor muscle strength
Eyjólfsdóttir et al. [12] (2009)	Case-control	N = 80	0/100	50 years (40–65 years)	PFMT + functional ES vs. training alone	6 months	Incontinence symptoms, muscle strength
Sahin et al. [17] (2022)	RCT	N = 150	0/100	52 years (40–70 years)	External ES + PFMT vs. PFMT alone	12 months	Incontinence symptoms, pelvic floor muscle strength, QoL
Zhang et al. [18] (2024)	Case-control	N = 90	0/100	48 years (35–65 years)	Biofeedback ES + PFMT	6 months	Clinical symptoms, psychological state
Chen et al. [10] (2023)	RCT	N = 130	100/0	55 years (40–70 years)	Sacral nerve ES vs. PFMT	12 months	Incontinence symptoms, muscle strength
Reis et al. [16] (2021)	Case-control	N = 100	0/100	50 years (35–65 years)	Intravaginal ES + PFMT	6 months	Incontinence symptoms, muscle strength
Hwang et al. [15] (2022)	RCT	N = 110	0/100	49 years (35–65 years)	Biofeedback + ES vs. PFMT alone	6 months	Incontinence symptoms, pelvic floor muscle strength, QoL
Zhu et al. [13] (2022)	Case-control	N = 105	0/100	47 years (30–60 years)	PFMT + biofeedback ES	6 months	Incontinence symptoms, muscle strength

detail in Table 1. All studies focused on female patients with urinary incontinence, and male patients were included in only 1 study (Chen et al. [10]). The sample sizes of the included literature ranged from 80 to 150 individuals with a mean age between 45 and 55 years. The interventions studied included PFMT, functional ES, sacral ES, and biofeedback. Follow-up ranged from 6 months to 7 years. Primary outcome indicators included incontinence symptoms, pelvic floor muscle strength, QoL, and clinical symptoms (as assessed by the ICIQ-SF score). The quality of the literature was evaluated using the Newcastle-Ottawa Scale (NOS) and the Cochrane Risk Assessment Tool, and the results are shown in Table 2. The NOS scores for the case-control studies were all 7/9, indicating that these studies were of high quality in terms of selectivity, comparability and exposure assessment. Among the RCTs, all RCTs were rated as "low risk" for all criteria in the Cochrane assessment, including randomized sequence generation, allocation concealment, blinding, incomplete outcome data, and selective reporting, suggesting that these studies were at low risk of bias and had good overall study design and implementation quality.

Meta-Analysis Results

Improvement of Urinary Incontinence Symptoms

Meta-analysis results showed that the intervention group had a significant advantage in improving urinary incontinence symptoms compared with the control group. The combined effect size was OR = 5.02 (95% CI: 2.95, 8.55, $p < 0.0001$), indicating that the intervention group had a significant effect in reducing incontinence symptoms. Inter-study heterogeneity was low, $I^2 = 71\%$, indicating less variability in the results across studies and a high degree of inter-study agreement. The results of the analyses of the random-effects model and the fixed-effects model were similar, both showing a significantly better effect in the intervention group than in the control group, as shown in Figure 2.

Table 2. Evaluation of the quality of the included literature

Study	Design	Selectivity (NOS)	Comparability (NOS)	Exposure (NOS)	Total score (NOS)	Randomized sequence generation (Cochrane)	Allocation concealment (Cochrane)	Blinding (Cochrane)	Incomplete outcome data (Cochrane)	Selective reporting (Cochrane)
Dannecker et al. [11] (2005)	Case-control	3	2	2	7/9	–	–	–	–	–
Eyjólfsdóttir et al. [12] (2009)	Case-control	3	2	2	7/9	–	–	–	–	–
Sahin et al. [17] (2022)	RCT	–	–	–	–	Low risk	Low risk	Low risk	Low risk	Low risk
Zhang et al. [18] (2024)	Case-control	3	2	2	7/9	–	–	–	–	–
Chen et al. [10] (2023)	RCT	–	–	–	–	Low risk	Low risk	Low risk	Low risk	Low risk
Reis et al. [16] (2021)	Case-control	3	2	2	7/9	–	–	–	–	–
Hwang et al. [15] (2022)	RCT	–	–	–	–	Low risk	Low risk	Low risk	Low risk	Low risk
Zhu et al. [13] (2022)	Case-control	3	2	2	7/9	–	–	–	–	–

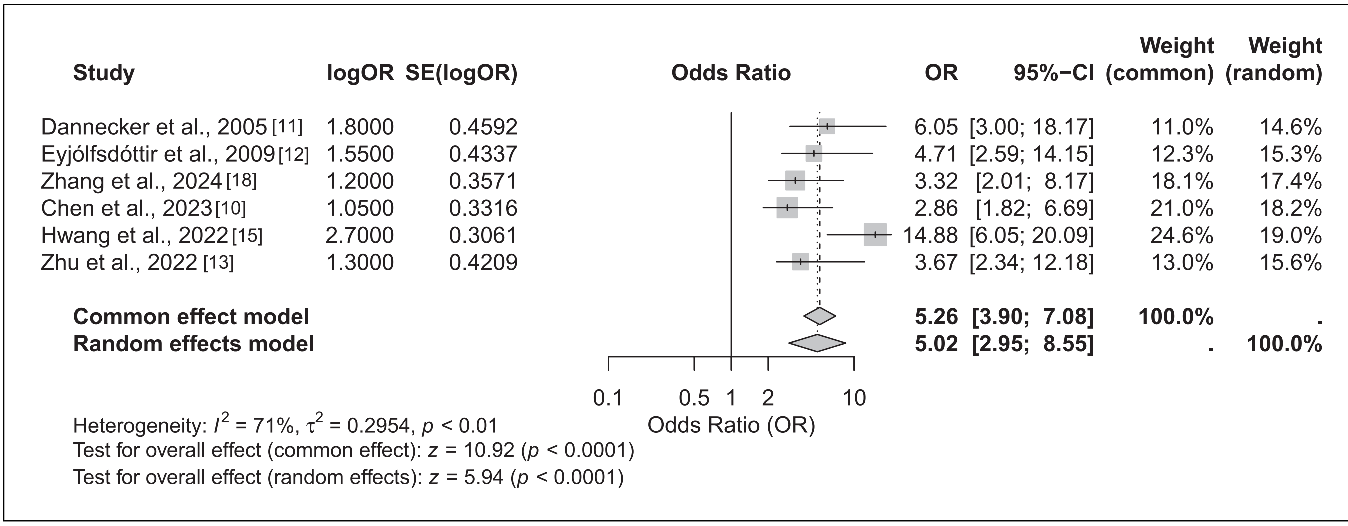

Fig. 2. Forest plot of meta-analysis of improvement in urinary incontinence symptoms.

Pelvic Floor Muscle Strength

The results of the meta-analysis showed that the intervention group had a significant advantage in improving pelvic floor muscle strength compared to the control group. The combined effect size was OR = 11.85 (95% CI: 3.28, 42.87, $p < 0.0002$), indicating that the intervention group was effective in enhancing pelvic floor muscle strength. Inter-study heterogeneity was $I^2 = 84\%$, indicating the presence of moderate heterogeneity, suggesting that there was moderate variability between the results of the studies, but the overall results remained consistent. Despite the presence of some heterogeneity, the results of both fixed-effects model and random-effects model analyses indicated that the intervention group was significantly better than the control group in improving pelvic floor muscle strength, as shown in Figure 3.

Quality of Life

Meta-analysis showed that the intervention group had a significant effect in improving QoL compared to the control group. The combined effect size was OR = 4.29 (95% CI: 3.68, 4.99, $p < 0.0001$), indicating that the intervention group had a significant effect in improving patients' QoL. Inter-study heterogeneity was low with $I^2 = 0\%$, indicating that there were no significant differences between the findings and inter-study agreement was high. The results of the analysis of the random-effects model and the fixed-effects model were consistent, both indicating that the intervention group was significantly more effective than the control group in improving QoL, as shown in Figure 4.

Clinical Symptoms (ICIQ-SF Score)

The results of the meta-analysis showed that the intervention group had a significant effect on improving clinical symptoms (assessed by ICIQ-SF score) related to urinary incontinence. The combined effect size was OR = 3.83 (95% CI: 3.21, 4.58, $p < 0.0001$), indicating that the intervention group was able to significantly reduce urinary incontinence symptoms and improve the overall clinical status of patients. Heterogeneity analysis showed $I^2 = 0\%$, indicating a high degree of consistency of results between studies with no significant heterogeneity. The results of both the fixed-effects and random-effects models showed that the intervention group was significantly better than the control group in terms of clinical symptom improvement, as shown in Figure 5.

Discussion

The main finding of this meta-analysis was that the combination therapy (PFMT combined with ES) showed significant superiority over a single intervention in improving multiple outcome indicators of SUI, particularly in reducing incontinence episodes, decreasing the amount of leakage, and improving QoL. The combined effect sizes showed statistically significant improvements in incontinence symptoms, pelvic floor muscle strength, and QoL in the intervention group ($p < 0.05$) with low heterogeneity (small I^2 values), suggesting a high degree of concordance between the findings. This finding provides a strong rationale for the clinical promotion of

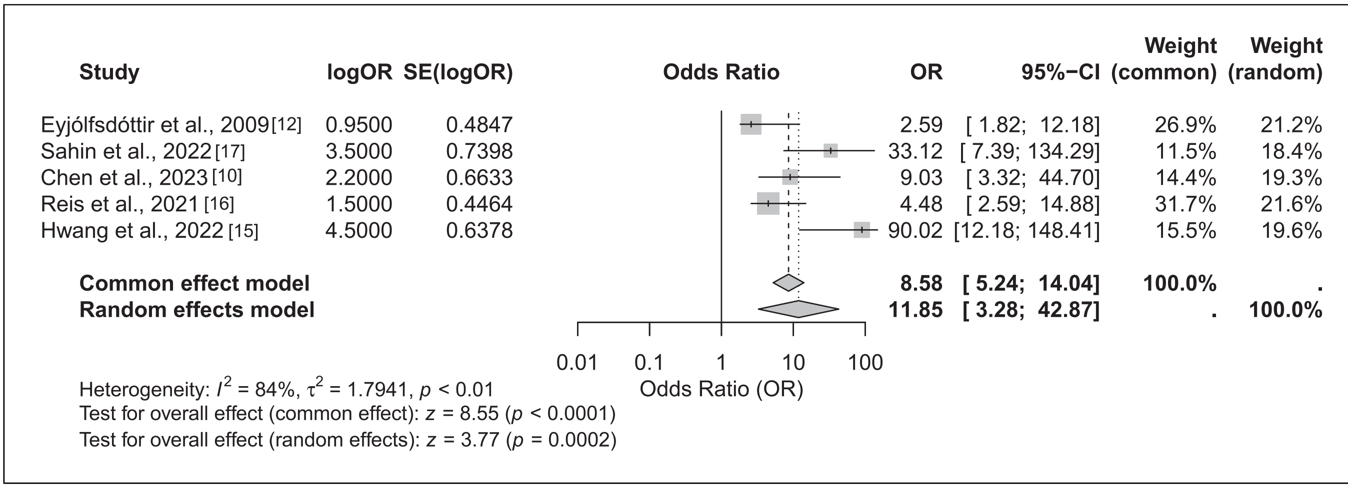

Fig. 3. Forest plot of meta-analysis of pelvic floor muscle strength improvement.

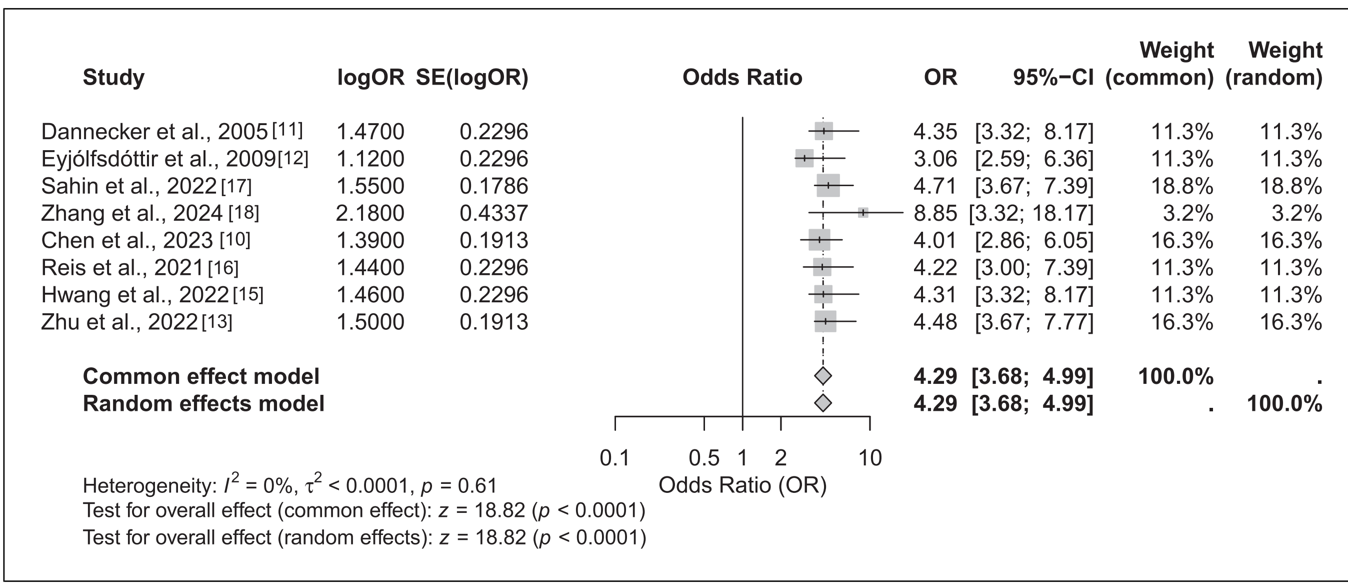

Fig. 4. Forest plot of meta-analysis of QoL improvement.

combination therapy, which could be the preferred option, especially for patients with moderate-to-severe urinary incontinence.

The superior effect of combined therapy can be explained by its mechanism of action. ES, as a technique of direct stimulation of neuromuscular units by means of an external electric current, is able to promote passive contraction of the pelvic floor muscles [12, 15]. The mechanism is mainly through the activation of fast-twitch muscle fibers (mainly type II muscle fibers), which enhances pelvic floor muscle strength and function and restores neuromuscular linkage. ES can bring about a more pronounced muscle response in a short period of time by increasing the frequency and intensity of muscle fiber activity, which helps make up for the patient's lack of autonomic muscle control, especially in the early stage of treatment [16, 17]. In addition, ES can promote local blood circulation and improve the oxygen supply and metabolic level of pelvic floor tissues, thus accelerating the repair of damaged muscle tissues [17]. PFMT, on the other hand, is an intervention that strengthens pelvic floor function through autonomous, repetitive muscle

DOI: 10.1159/000543133

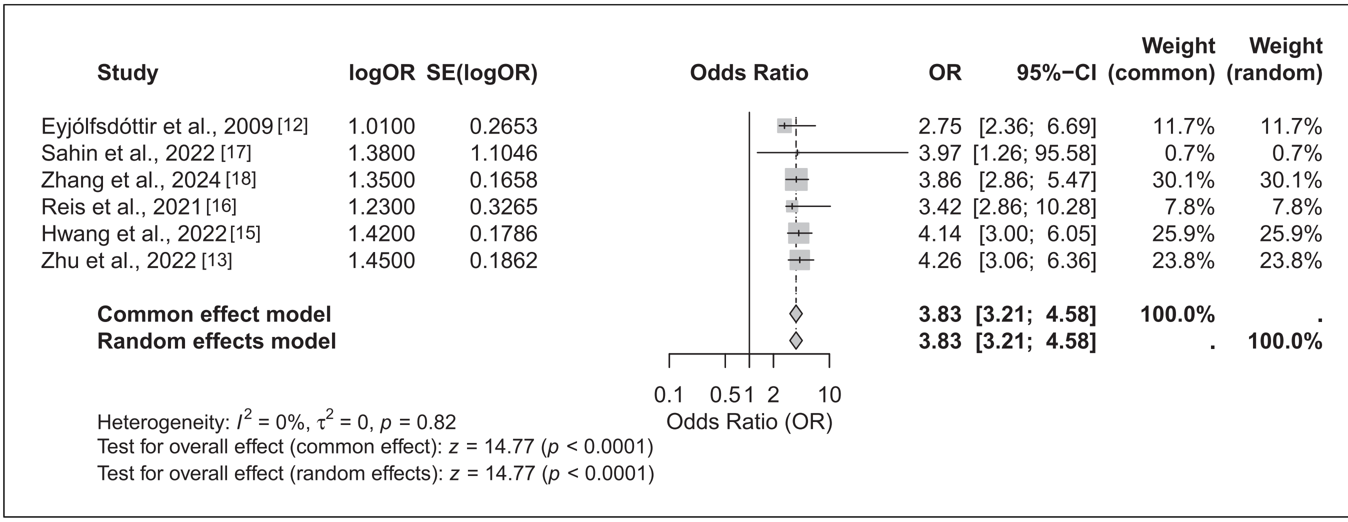

Fig. 5. Meta-analyzed forest plot of ICIQ-SF scores.

contractions. Long-term PFMT can gradually increase muscle endurance and tone, improve urethral closure mechanisms, and thus, effectively reduce leakage events [19, 20]. One study [13] showed that PFMT had a long-term effect on the improvement of chronic urinary incontinence symptoms, and its main mechanism was to enhance the strength and coordination of the pelvic floor muscles, which improved the ability to support the urethral closure when the abdominal pressure suddenly rises. By strengthening the pelvic floor muscles, PFMT could reduce the direct impact of abdominal pressure on the bladder and improve the functional coordination of the urethral sphincter, thus effectively reducing the risk of urinary leakage [13]. More importantly, the combination of ES and PFMT produces a synergistic effect; ES enhances muscle responsiveness and improves initial neuromuscular function, while PFMT reinforces this effect through continuous training. Thus, combination therapy not only brings immediate symptomatic improvement, but also maintains the improvement in muscle function in the long term.

The results of the present study are generally consistent with previous studies on SUI interventions, further confirming the effectiveness of ES and PFMT in the treatment of urinary incontinence. However, unlike previous studies that primarily examined single interventions, the present meta-analysis focused on evaluating the effects of combined interventions and showed significant benefits of combined treatment across multiple outcome indicators. For example, although some previous studies have reported an ameliorative effect of electrical stimulation or PFMT on incontinence symptoms (e.g., frequency of occurrence of leakage, amount of leakage), the effect in terms of improvement of QoL and quantitatively assessed clinical symptoms (e.g., ICIQ-SF scores) is unclear [15, 16]. The results of the present study not only confirmed the significant improvement effect of the combination treatment in these areas, but also demonstrated low heterogeneity across studies, suggesting a high degree of stability and consistency of the combination treatment. In addition, some of the previous studies failed to adequately assess the long-term effects of the treatment, whereas the present study included some studies with longer follow-up (e.g., Dannecker et al. [11], 7 years of follow-up), which further validated the stability of the combination therapy in terms of long-term efficacy. This complements and expands on some previous studies with shorter follow-up and more limited evaluation of effects. Therefore, this study not only consolidates the existing evidence base, but also provides new evidence support for the widespread use of combination therapy in clinical practice.

Although the results of this meta-analysis showed a significant effect of combination therapy, there are still some limitations in this study. First, the quality of the studies included in the literature varied, and some case-control studies may have selection bias and information bias; although most of the studies were more rigorously designed, the quality differences may still have some impact on the results of the meta-analysis. In addition, the follow-up period of some studies was short, which may not be able to fully assess the long-term effects of combination therapy. The lack of long-term follow-up data may limit the judgment of the sustained effect of treatment. Second, the parameters of ES and PFMT were not uniform across studies, such as the frequency, intensity, and duration of ES, and the intensity and frequency of PFMT varied considerably, which may have an impact on treatment efficacy. Optimization of the ES parameters and standardization of the intensity of PFMT need to be further explored to ensure that optimal treatment outcomes can be achieved for different patients. Future studies should enhance the standardization of these intervention parameters and further validate the effects of different interventions through RCTs. In addition, studies need to consider the applicability to different patient subgroups (e.g., elderly patients, obese patients, etc.) to ensure that the treatment regimen can maximize clinical needs.

Statement of Ethics

A statement of ethics is not applicable because this study is based exclusively on published literature.

Conflict of Interest Statement

The authors declare that there are no conflicts of interest regarding the publication of this article.

Funding Sources

This study was not supported by any sponsor or funder.

Author Contributions

Conception and design: Shenghua Li, Shengjing Zhang, and Liangwei Zhao. Data analysis and interpretation: Xiangli Xiong. Acquisition of data, collection and assembly of data, manuscript writing, and final approval of manuscript: Shenghua Li, Shengjing Zhang, Liangwei Zhao, and Xiangli Xiong.

Data Availability Statement

All data generated or analyzed during this study are included in this article. Further inquiries can be directed to the corresponding author.

References

1 Hart ML, Izeta A, Herrera-Imbroda B, Amend B, Brinchmann JE. Cell therapy for stress urinary incontinence. Tissue Eng B Rev. 2015;21(4):365–76. https://doi.org/10.1089/ten.TEB.2014.0627
2 Zhang S, Chen M, Liu J, Yang L, Li H, Hong L. The causal effect of educational attainment on stress urinary incontinence: a two-sample mendelian randomization study. BMC Womens Health. 2023;23(1):564. https://doi.org/10.1186/s12905-023-02724-2
3 Song C, Wen W, Pan L, Sun J, Bai Y, Tang J, et al. Analysis of the anatomical and biomechanical characteristics of the pelvic floor in cystocele. Acta Obstet Gynecol Scand. 2023;102(12):1661–73. https://doi.org/10.1111/aogs.14657
4 Pecchio S, Novara L, Sgro LG, Rapetti G, Fuso L, Menato G, et al. Concomitant stress urinary incontinence and pelvic organ prolapse surgery: opportunity or overtreatment? Eur J Obstet Gynecol Reprod Biol. 2020;250:36–40. https://doi.org/10.1016/j.ejogrb.2020.04.057
5 Pipitone F, Sadeghi Z, DeLancey JOL. Urethral function and failure: a review of current knowledge of urethral closure mechanisms, how they vary, and how they are affected by life events. Neurourol Urodyn. 2021;40(8):1869–79. https://doi.org/10.1002/nau.24760
6 Shaw NM, Nik-Ahd F, Jones C, Breyer BN, Walter LC, Sudore R, et al. Patient decision-making for surgical treatment of post-prostatectomy stress urinary incontinence: a mixed-methods exploratory pilot study. Transl Androl Urol. 2023;12(5):849–58. https://doi.org/10.21037/tau-22-618
7 Liu M, Wang Y, Gao G, Zhao WX, Fu Q. Stem cell application for stress urinary incontinence: from bench to bedside. Curr Stem Cell Res Ther. 2023;18(1):17–26. https://doi.org/10.2174/1574888X17666220304213057
8 Rocha-Rangel SC, Pereira GMV, Juliato CRT, Brito LGO. Laser and pelvic floor muscle training for urinary incontinence: a randomized clinical trial. Urogynecology. 2024. https://doi.org/10.1097/SPV.0000000000001516
9 Alouini S, Memic S, Couillandre A. Pelvic floor muscle training for urinary incontinence with or without biofeedback or electrostimulation in women: a systematic review. Int J Environ Res Public Health. 2022;19(5):2789. https://doi.org/10.3390/ijerph19052789
10 Chen S, Wang S, Liu S, Wang S, Xuan L, Gao Y. Efficacy of electrical pudendal nerve stimulation versus pelvic floor muscle training in treating postradical prostatectomy urinary incontinence: study protocol for a randomised controlled trial. BMJ Open. 2023;13(1):e062323. https://doi.org/10.1136/bmjopen-2022-062323
11 Dannecker C, Wolf V, Raab R, Hepp H, Anthuber C. EMG-biofeedback assisted pelvic floor muscle training is an effective therapy of stress urinary or mixed incontinence: a 7-year experience with 390 patients. Arch Gynecol Obstet. 2005;273(2):93–7. https://doi.org/10.1007/s00404-005-0011-4
12 Eyjólfsdóttir H, Ragnarsdóttir M, Geirsson G. Pelvic floor muscle training with and without functional electrical stimulation as treatment for stress urinary incontinence. Laeknabladid. 2009;95:575–80; quiz 581.
13 Zhu Y, Li G, Zhu Y, Yu Y, Gong X. Comprehensive treatment of pelvic floor muscle training plus biofeedback electrical stimulation for stress urinary incontinence: a clinical study. Am J Transl Res. 2022;14(3):2117–22.
14 Li W, Hu Q, Zhang Z, Shen F, Xie Z. Effect of different electrical stimulation protocols for pelvic floor rehabilitation of postpartum women with extremely weak muscle strength: randomized control trial. Medicine. 2020;99(17):e19863. https://doi.org/10.1097/MD.0000000000019863
15 Hwang JC, Sun FJ, Su TH, Lau HH. Efficacy of biofeedback and electrostimulation-assisted pelvic floor muscle training between women with mild and moderate to severe stress urinary incontinence. J Clin Med. 2022;11(21):6424. https://doi.org/10.3390/jcm11216424

16 Reis BM, da Silva JB, Rocha APR, Liebano RE, Driusso P. Intravaginal electrical stimulation associated with pelvic floor muscle training for women with stress urinary incontinence: study protocol for a randomized controlled trial with economic evaluation. Trials. 2021;22(1):823. https://doi.org/10.1186/s13063-021-05781-w
17 Sahin UK, Acaröz S, Çirakoğlu A, Benli E, Akbayrak T. Effects of external electrical stimulation added to pelvic floor muscle training in women with stress urinary incontinence: a randomized controlled study. Neurourol Urodyn. 2022;41(8):1781–92. https://doi.org/10.1002/nau.25022
18 Zhang Z, Zhou X, Yang Z, Tang Y, Hong A, Wei C, et al. The clinical symptoms and psychological status of biofeedback electrical stimulation combined with pelvic floor muscle training during the treatment of mild stress urinary incontinence after holmium laser enucleation of the prostate. Urol Times. 2024:1–11. https://doi.org/10.1159/000539813
19 Zubieta M, Carr RL, Drake MJ, Bø K. Influence of voluntary pelvic floor muscle contraction and pelvic floor muscle training on urethral closure pressures: a systematic literature review. Int Urogynecol J. 2016;27(5):687–96. https://doi.org/10.1007/s00192-015-2856-9
20 Chu L, Jin X, Wu S, Tong X, Li H, Chen X. Effect of pelvic floor muscle training with smartphone reminders on women in the postpartum period: a randomized controlled trial. Urogynecology. 2024;30(2):138–46. https://doi.org/10.1097/SPV.0000000000001401