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Original Article

Acupuncture combined with pelvic floor muscle training for treating postpartum stress urinary incontinence

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Abstract: Objective: To explore the clinical application of acupuncture combined with pelvic floor muscle training (PFMT) in treating postpartum stress urinary incontinence (PSUI) based on patient data. Methods: A retrospective analysis was performed on 97 PSUI patients treated at the Second People's Hospital of Nantong from July 2021 to June 2023. Patients voluntarily chose between the two treatment groups: PFMT alone or the combination of acupuncture and PFMT. Multiple indicators, including pad test positive rate, urinary scores, leakage volume, incontinence degree, treatment effectiveness, pelvic floor muscle strength, and sexual quality of life, were compared between the two groups. Results: The pad test positive rate was significantly lower in the combined treatment group (7.69%) than in the PFMT group (28.89%) ($P = 0.013$). The combined treatment group had lower urinary scores ($t = 9.288$-16.020, all $P < 0.001$) and higher overall efficacy (92.31% vs. 68.89%, $P < 0.05$). Both groups demonstrated improved pelvic floor muscle strength, with the combined intervention group showing greater enhancement compared to PFMT alone ($P < 0.05$). Urinary leakage volume and incontinence degree scores decreased more in the combined treatment group ($P < 0.001$) than in the PFMT group ($P < 0.001$ between groups). The combined treatment group had better sexual quality of life and greater reductions in SAS and SDS scores ($P < 0.05$). Conclusion: Acupuncture combined with PFMT demonstrated significantly superior outcomes to PFMT alone for PSUI treatment, with significant improvements in incontinence symptoms, psychological status, muscle strength, and quality of sexual life. Findings support the clinical adoption of this combined strategy for PSUI.

Keywords: Acupuncture, pelvic floor muscle training, postpartum, stress urinary incontinence, efficacy

Introduction

As a common type of urinary disorder, stress urinary incontinence (SUI) is characterized by involuntary urine leakage through the urethra due to increased abdominal pressure caused by inability of the detrusor to contract [1]. Its typical manifestation is urine storage disorder [2]. Related research has indicated that 33.3% of women experience SUI after childbirth [3]. Factors such as pregnancy, vaginal delivery, and caesarean section can cause excessive stretching or damage to the pelvic muscles, nerves, and connective tissue, resulting in pelvic organ displacement, thereby impairing urinary control after childbirth. When the abdominal pressure is elevated, combined with impaired detrusor contractility and increased tone of muscle wall of the bladder, involuntary overflow incontinence may occur. This condition can manifest as postpartum stress urinary incontinence (PSUI), which seriously affects the postpartum recovery and maternal quality of life [4]. Currently, there is no standardized, widely acceptable, and reliably effective clinical treatment for PSUI.

Pelvic floor muscle training (PFMT) is a treatment that involves regular exercise of the pelvic floor muscles to enhance muscle contraction, thereby mitigating urinary leakage [5]. Owing to its flexibility, PFMT can be performed at any time and setting, making it a highly convenient and accessible therapeutic option. However, the extended duration required for the treatment, coupled with poor patient adherence and lack of self-discipline, poses great challenges for most patients to maintain regular exercise regimens, thereby compromising the overall efficacy of the intervention.

In addition to PFMT, acupuncture has also been explored as a treatment option for SUI, particularly from the perspective of traditional Chinese

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medicine (TCM). According to the theory of TCM, acupuncture helps to regulate the pelvic floor muscle activity, and to improve the function of the bladder by stimulating specific acupoints with needles so as to reduce urinary incontinence [6]. Clinical studies have demonstrated that acupuncture is effective in treating PSUI in women, with a reported effective rate of 92.5%, and it has been shown to alleviate urinary incontinence, improve voluntary control of urination, and enhance overall quality of life [7].

Notably, previous research has predominantly examined individual efficacy of PFMT or acupuncture in treating PSUI, while few studies have explored the synergistic effects of combining the two treatments. Moreover, most investigations were conducted under controlled experimental conditions, which may have restricted the generalizability of their findings in practice.

In contrast, this study represented a pioneering effort by using clinical data to analyze the combined application of PFMT and acupuncture for treating PSUI. By adopting a retrospective design grounded in clinical settings, this study aimed to assess not only the efficacy but also the practicality of this integrated therapeutic approach in a diverse patient population. This not only addresses the existing research gap regarding the combined therapy, but also provides a more pragmatic and clinically applicable evidence base, offering a novel insight and a therapeutic paradigm for the management of PSUI.

Given that both PFMT and acupuncture have demonstrated effectiveness in managing PSUI, and considering the current lack of research on their combined use, this study seeks to provide evidence supporting the efficacy of the combined treatment. This should provide a practical foundation for broader clinical promotion and application of this approach for PSUI.

Materials and methods

Baseline characteristics

A retrospective analysis was conducted on 97 patients with PSUI who were treated in Nantong Second People's Hospital from July 2021 to June 2023. Based on their clinical condition and personal willingness, patients voluntarily chose either PFMT (PFMT group, 45 cases) or acupuncture combined with PFMT (combined treatment group, 52 cases). Inclusion criteria: (1) patients diagnosed with PSUI [8]; (2) patients with PSUI classified as grade I; (3) patients who had a full-term singleton vaginal delivery; (4) patients with normal post-void residual volume and bladder volume confirmed by ultrasonography; (5) patients with normal results on urinalysis and vaginal discharge test. Exclusion criteria: (1) patients with malignant tumor; (2) patients with mental disorders, neurological disorders, and cognitive dysfunction; (3) patients with chronic constipation or diarrhea; (4) patients with complications that affect the function of the bladder, such as vesicovaginal fistula, cystitis or urethritis; (5) patients with incomplete follow-up data or clinical data.

The flowchart of CASES inclusion, exclusion, and grouping study is shown in **Figure 1**. This study was approved by the Ethics Committee of Second People's Hospital of Nantong.

Diagnostic criteria

The diagnostic criteria for PSUI are as follows [9]: (1) Sign: Observable urine leakage from the urethra under increased abdominal pressure, such as during a cough stress test, or urine loss exceeding 1 g as measured by a 1-hour pad test. (2) Symptoms: Involuntary urine leakage triggered by activities that increase abdominal pressure, such as walking, sneezing, coughing, or laughing, which will disappear upon cessation of these activities. (3) No presence of urinary urgency and urinary frequency. Typical electromyograms of the pelvic floor muscles are shown in **Figures 2** and **3**.

Treatment methods

PFMT group: Patients in the PFMT group received individualized guidance from trained personnel, who provide one-on-one instruction to ensure proper execution of pelvic floor muscle exercises. Prior to initiating the exercises, patients were informed of the schedule, purpose, significance, and precautions of the PFMT. The core of the training focused on how to control anal muscle contractions. Patients were instructed to lie in a supine position, relax, and bend the legs so that the soles of the feet rest flat on the bed; then, they were guided to contract their anal muscles while lifting the

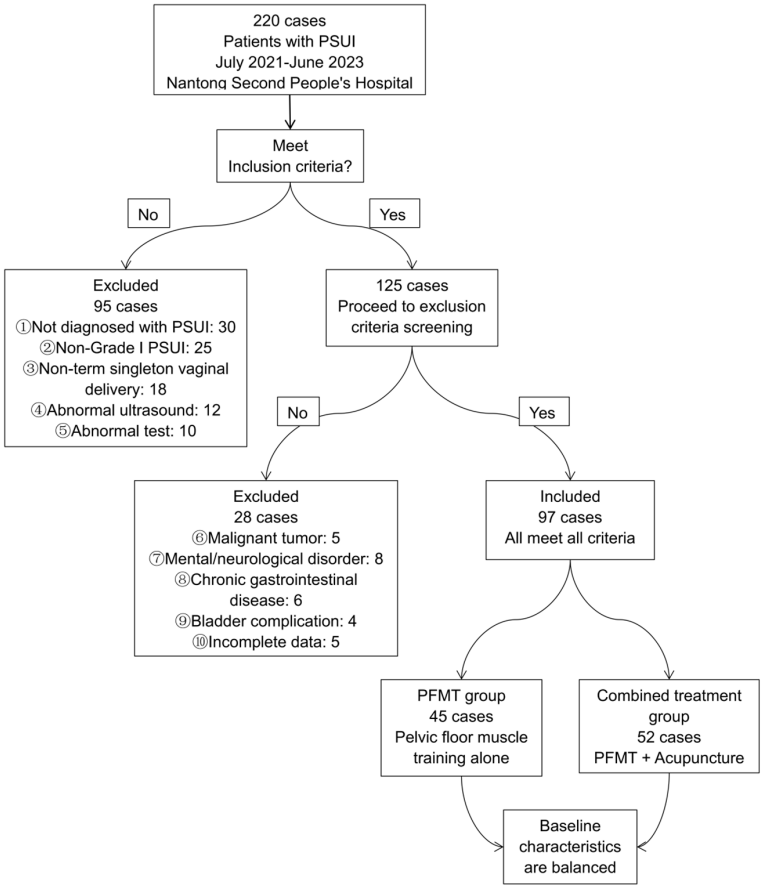

Figure 1. Flow chart of cases inclusion, exclusion, and grouping study. Note: PFMT: PSUI: postpartum stress urinary incontinence; pelvic floor muscle training.

hips, maintaining this position for 15 seconds, followed by slowly returning the hips to resting position and relaxing the waist. During this process, the patient should avoid abdominal pressure caused by inspiration and avoid using the strength of leg and hip muscles. The training regimen consisted of 10 repetitions each session, performed three times daily (morning, noon, and evening) over a 12-week period.

Combined treatment group: In addition to PFMT, patients in the combined treatment group also received acupuncture. Acupuncture methods: Acupuncture was administered with the patient in a supine position. After skin disinfection, the acupuncturist quickly inserted the disposable sterile filiform needles (50 mm) into specific acupoints selected based on their relevance to pelvic floor and urinary function.

The acupoints included: Zhongji (CV3), located on the anterior median line of the lower abdomen, 4 cun below the umbilicus, regulates the functions of the bladder and promote Qi circulation in the lower-jiao, which is beneficial for relieving urinary disorders; Zigong (EX-CA1), an extra-meridian point, mainly acts on the female reproductive system and pelvic floor muscles, helping to strengthen the pelvic floor and alleviate related symptoms; Guanyuan (CV4), 3 cun below the umbilicus on the anterior median line, is regarded as a vital point for tonifying the kidney and regulating the reproductive and urinary systems, playing a key role in enhancing the body's overall function; Qihai (CV6), 1.5 cun below the umbilicus on the anterior median line, is used to tonify the Qi of the lower abdomen, to promote Qi movement, and to improve the function of pelvic organs.

Chize (LU5), the He-Sea point of the Lung Meridian of Hand-Taiyin, can clear lung heat and regulate Qi in the upper body. It also has an impact on the overall Qi-blood circulation, which may indirectly support pelvic floor function. Taiyuan (LU9), the Yuan-Source point of the Lung Meridian, is essential for tonifying lung Qi, and maintaining normal Qi-blood flow throughout the body, including the pelvic region. Baihui (GV20), located at the vertex of the head, is employed to lift Yang Qi and regulate the upward flow of Qi. By promoting the upward movement of Qi, it can help to enhance the support of pelvic organs. Yinlingquan (SP9), the He-Sea point of the Spleen Meridian of Foot-Taiyin, has the functions of invigorating the spleen, resolving dampness, and promoting the metabolism of body fluids in the lower body, which is closely related to the regulation of urinary function.

Ligou (LR5), the Luo-Connecting point of the Liver Meridian, is involved in the regulation of liver and gallbladder Qi. Given the liver meridian runs through the lower abdomen and pelvis, stimulation of this point may help regulate the

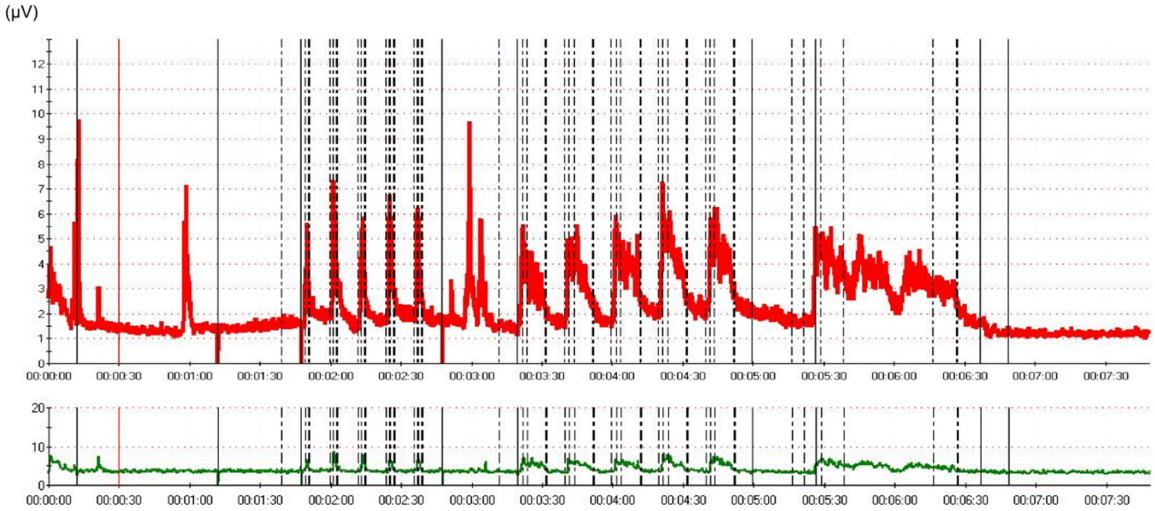

Figure 2. Electromyogram of the pelvic floor muscles. Note: Pre-resting phase: This phase tests the muscle state at rest. A value > 4 μV, accompanied by variability exceeding the reference range, may suggest possible muscle overactivity. Rapid contraction phase: It is used to assess the function of fast-twitch muscles. A markedly low maximum value indicates insufficient muscle strength, while abnormal relaxation times may reflect potential muscle overactivity. Tense contraction phase: This phase measures the strength of slow-twitch muscles. An abnormally low average value indicates insufficient muscle strength, whereas elevated variability indicates poor muscle stability. Endurance contraction phase: It examines the endurance of slow-twitch muscles. A very low average value implies diminished endurance of slow-twitch muscles. Post-resting phase: This phase determines whether the muscle returns to its normal state following a series of contractions. A value > 4 uv, together with the variability above the reference threshold, may suggest muscle overactivity.

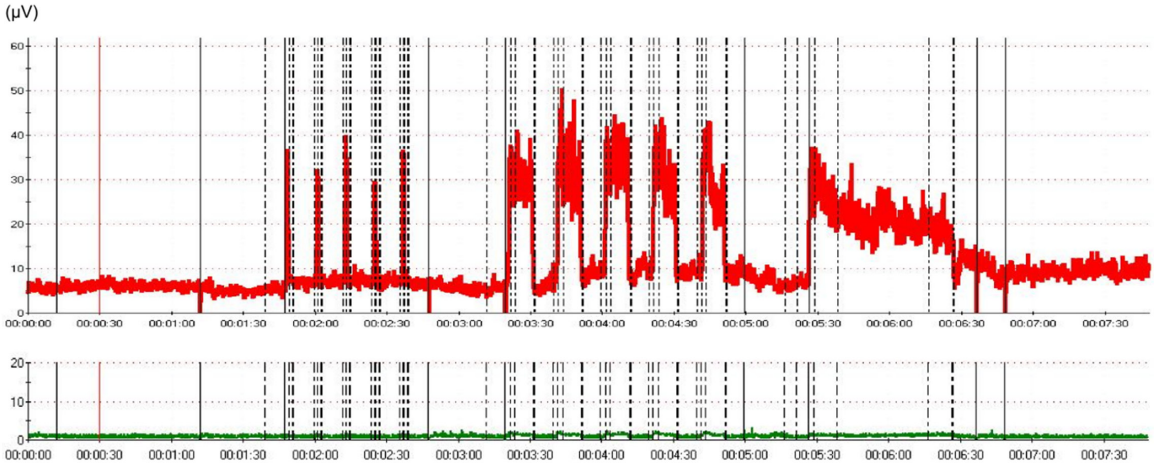

Figure 3. Electromyogram of the pelvic floor muscles. Note: Pre-resting phase: This phase tests the muscle state at rest. A value > 4 μV, accompanied by variability exceeding the reference range, may suggest possible muscle overactivity. Rapid contraction phase: It is used to assess the function of fast-twitch muscles. A markedly low maximum value indicates insufficient muscle strength, while abnormal relaxation times may reflect potential muscle overactivity. Tense contraction phase: This phase measures the strength of slow-twitch muscles. An abnormally low average value indicates insufficient muscle strength, whereas elevated variability indicates poor muscle stability. Endurance contraction phase: It examines the endurance of slow-twitch muscles. A very low average value indicates diminished endurance of slow-twitch muscles. Post-resting phase: This phase determines whether the muscle returns to its normal state following a series of contractions. A value > 4 uv, together with the variability above the reference threshold, may suggest potential muscle overactivity.

function of pelvic floor muscles. Taixi (KI3), the Yuan-Source point of the Kidney Meridian, is crucial for tonifying both kidney Yin and Yang. As the kidney is closely related to the body's

water metabolism and the function of pelvic organs, this point plays an important role in treating urinary incontinence. Zusanli (ST36), a key point of the Stomach Meridian of Foot-Yangming, strengthens the spleen and stomach, promoting the transportation and transformation of nutrients. It also exerts broad regulatory effects on the body and enhances self-healing ability. Sanyinjiao (SP6), the intersection point of the Spleen, Liver, and Kidney Meridians of Foot-Taiyin, can tonify the three yin meridians simultaneously. It is widely applied in treating gynecological and urinary diseases, effectively improving the function of pelvic floor muscles and bladder control.

A standardized reinforcing-reducing acupuncture manipulation technique was applied by the acupuncturist, involving gentle lifting, inserting, and twirling after reaching the appropriate depth. Patients were treated with acupuncture once daily for 30 minutes. One course of treatment consisted of 10 acupuncture treatments, delivered every other day, over a total treatment duration of 12 weeks.

Observation indicators

Primary observation indicators: (1) Pad test for urine leakage: Urinary leakage was measured by standardized pad test [10]. A wet pad indicated a positive result for leakage, and a dry pad indicated a negative result. (2) Urinary frequency score (range 1-5) [11]: Patients completed a urinary frequency questionnaire at the 1st, 2nd, and 3rd weeks post-treatment to assess symptom improvement [11]. Scoring was based on leakage frequency: ≤ 1 time/week, 1 point; 2-3 times/week, 2 points; 4-7 times/week, 3 points; multiple times/day, 4 points; continuous urine leakage, 5 points. (3) Volume of urinary leakage: urine leakage volume was measured using 1-hour pad test protocol. Patients were required to empty their bladder 15 minutes before the test, then put on a urine pad, and drink 500 mL of water. They then engaged in a sequence of physical activities: walking and climbing the stairs for 30 minutes, followed by standing, sitting, coughing (15 minutes), running in place (1 minute), bending forward 5 times, and hand washing (1 minute). The urine pad was removed and weighed by three independent physicians. The pad's original weight was subtracted from the measured weight, and the difference was recorded. The average of the three measurements was recorded as the urine leakage volume. (4) Urodynamic parameters: Bladder pressure was assessed using room-temperature saline infused at a controlled rate to prevent urethral trauma. The leakage points were determined in the sitting position after the bladder was filled with 250 mL of saline solution. Urodynamic indicators included the Valsalva leak point pressure (VLPP), maximum urethral closure pressure (MUCP), maximum urethral pressure (MUP), bladder compliance (BC), functional urethral length (FUL), Maximum Cystometric Capacity (MCC), and detrusor pressure at maximum urine flow rate (PdetQmax) were measured using a urinary kinetics analyzer (Nidoc 970 b, Haijumu Medical Equipment Co., LTD). (5) Urinary incontinence severity scores: The frequency of urinary incontinence per week was used to assess severity scores [12]. The frequency of urine leakage: ≤ 1 time/week, 1 point; 2 or 3 times/week, 2 points; 4-7 times/week, 3 points; daily leakage, 4 points; persistent urine leakage, 5 points. (6) Criteria for evaluating treatment efficacy [13]: Ineffective: No improvements in symptoms and signs; urine leakage occurred with increased abdominal pressure; inability to control urination; disrupted daily life. Mostly effective: Improved symptoms and signs; significantly reduced frequency of urinary incontinence; occasional leakage with abdominal pressure; basic return to normal life. Fully effective: Complete resolution of symptoms; no urine leakage observed with elevated abdominal pressure; fully control of urination; return to a normal life.

Secondary observation indicators: (1) Pelvic floor strength test: Pelvic floor strength was evaluated using the pelvic floor muscle strength test [14]. Patients were instructed to contract their vagina, and the duration and the number of consecutive vaginal contractions was recorded. Muscle strength was graded according to the criteria outlined in **Table 1**. (2) Pelvic floor muscle electromyogram: Electromyogram signals were measured using MLD-JW-C005-H0001, a multifunctional pelvic floor biological stimulation feedback instrument (Nanjing McLand Medical Technology Co., LTD.). Patients were positioned in a semi-decubitus gesture, with a sterilized myopotential probe inserted into their vagina, and the maximum amplitude of the fast muscle was recorded. (3) Postpartum sexual function: The female sexual

Table 1. Pelvic floor muscle strength grading

Level	Vaginal muscle contraction
Level 0	Failure to contract
Level I	Slight contraction once (1 s)
Level II	Incomplete contraction twice (2 s)
Level III	Complete contraction thrice (3 s) with no resistance
Level IV	Complete contraction 4 times (4 s) with slight resistance
Level V	Complete contraction ≥ 5 times (4 s) with continuous resistance

Table 2. Baseline characteristics of study participants [$\bar{x}$±s, n (%)]

Baseline characteristics	PFMT group (n = 45)	Combined treatment Group (n = 52)	t/χ^2	*P*
Age (years)	26.89±3.12	27.04±3.38	0.226	0.822
Height (cm)	159.78±4.15	160.10±4.22	0.375	0.708
BMI (kg/m^2)	25.24±2.43	25.17±2.63	0.135	0.893
Parity			0.627	0.428
First pregnancy	25 (55.56)	33 (63.46)		
Subsequent pregnancy	20 (44.44)	19 (36.54)		
Pregnancy duration (weeks)	38.43±1.37	38.08±1.45	1.216	0.227
Disease Duration (d)	14.46±3.02	14.53±3.11	0.112	0.911
Weight of newborns (kg)	3.53±0.26	3.51±0.24	0.394	0.695

PFMT: pelvic floor muscle training; BMI: body mass index.

function index (FSFI) [15] was used to evaluate the sexual function across six dimensions: sexual desire, sexual arousal, vaginal lubrication, orgasm, sexual satisfaction, and pain during intercourse. 2-36 points: Poorer sexual function; < 21 points: Low quality of sexual life; ≥ 21 and < 29 points: Moderate quality of sexual life; ≥ 29 points: High quality of sexual life. (4) Psychological assessment: Postpartum psychological status of the two groups was assessed using Self-rating Depression Scale (SDS) [16] and Self-rating Anxiety Scale (SAS) [17]. Higher scores reflect more severe negative emotions.

Statistical analysis

SPSS 23.0 software was used for statistical analysis. Quantitative data were expressed as mean ± standard deviation (x ± s). Independent samples t-test or paired t-test was used to compare the mean differences between the two groups. Repeated measures analysis of variance (Repeated Measures ANOVA) and post-hoc tests were used to compare the mean differences across more than two time points. Qualitative data were expressed as frequency and percentage (n%) and tested by chi-square test (χ^2) or Fisher's exact test. A *P*-value of < 0.05 was considered significant.

Results

Baseline characteristics

There were no statistically significant differences between the two groups in terms of age, height, BMI, gestational age, or birth weight of newborns (*P* > 0.05), as shown in **Table 2**.

Overall treatment efficacy

The combined treatment group demonstrated a significantly higher overall efficacy rate of 92.31%, compared to 68.89% in the PFMT group (*P* < 0.05) (**Table 3**). This finding suggests that the integrated approach of acupuncture and PFMT was more effective in treating PSUI.

Primary outcome: urinary incontinence improvement

Pad test results: As shown in **Figure 4**, the positive case rate in the combined treatment group was 7.69% (4/52), significantly lower than 28.89% (13/45) in the PFMT group (χ^2 = 6.104,

Table 3. Treatment efficacy between PFMT group vs. combined treatment group [n (%)]

Efficacy	PFMT group (n = 45)	Combined treatment Group (n = 52)	χ^2/Z	*P*
Ineffective	14 (31.11)	4 (7.69)	-2.688	0.007
Mostly Effective	10 (22.22)	12 (23.08)		
Fully effective	21 (46.67)	36 (69.23)		
Overall efficacy	31 (68.89)	48 (92.31)	7.273	0.007

PFMT: pelvic floor muscle training.

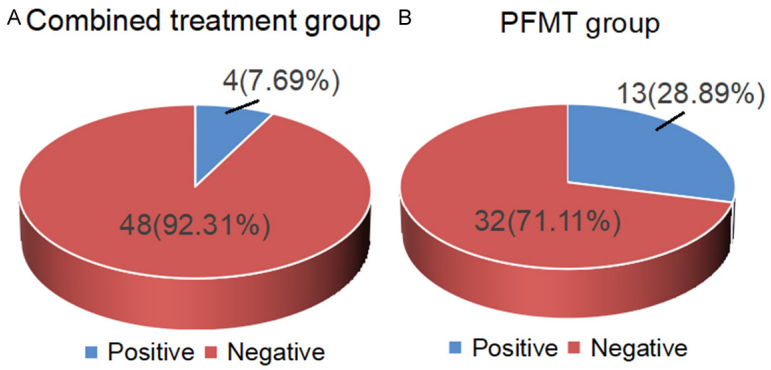

Figure 4. Rates of positive cases detected by pad tests between combined treatment group vs PFMT group. Note: The rate of positive cases of the combined treatment group (n = 52) was lower than that of pelvic floor muscle training (PFMT) group (n = 45) (*P* < 0.05). A. Combined treatment group; B. PFMT group.

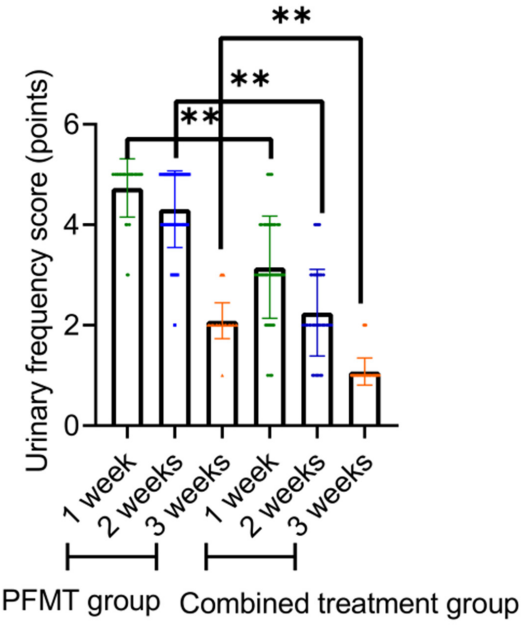

Figure 5. Comparison of urinary frequency score between PFMT group vs combined treatment group. Note: **indicated that a statistically significant difference was found in comparison between two groups (*P* < 0.05). Urinary frequency in the combined treatment group were lower than those in the PFMT group at 1 week, 2 weeks, and 3 weeks after treatment. PFMT: pelvic floor muscle training.

P = 0.013). This result directly reflected the effectiveness of the combined interventions in reducing the occurrence of urine leakage.

Urination situation scores: Urination scores in the combined treatment group were significantly lower than those in the PFMT group at 1 week (t = 9.288, *P* < 0.001), 2 weeks (t = 12.570, *P* < 0.001), and 3 weeks (t = 16.020, *P* < 0.001) after treatment; Post-hoc tests showed significant differences in comparisons between any two time points in any group (*P* < 0.05) (**Figure 5**). Both groups showed a decreasing trend in scores over time (F = 312.000, *P* < 0.001), with combined treatment group showing a more pronounced decline (F = 235.600, *P* < 0.001). Significant differences were observed both between groups and across time points (F = 8.950, *P* < 0.001), further indicating its superiority in improving the subjective perception of urinary symptoms.

Urinary leakage volume and incontinence degree score: Before treatment, there were no significant differences found in urinary leakage volume (t = 0.914, *P* = 0.363) or incontinence degree score (t = 0.062, *P* = 0.951) between the two groups. After treatment, both indicators experienced significant decreases in both groups (*P* < 0.001). However, the combined treatment group achieved greater decreases, with significantly lower urinary leakage volume and incontinence degree score than the PFMT group (t = 4.370 and 6.107, respectively; both *P* < 0.001) (**Figure 6**). This indicated that the combined treatment was more effective in quantitatively reducing the severity of urinary incontinence.

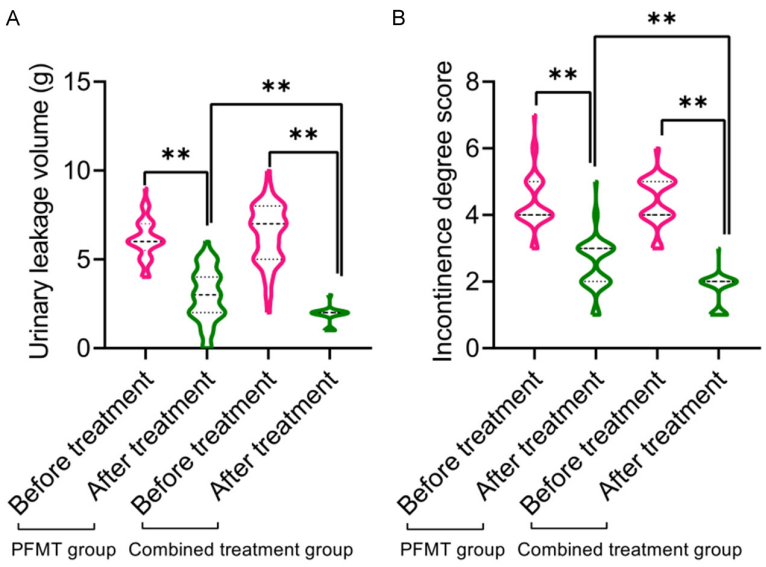

Figure 6. Comparison of urinary leakage volume and incontinence degree score between PFMT group vs combined treatment group. Note: Before treatment, there were no significant differences between the two groups in urinary leakage volume and incontinence degree score, while after treatment, both groups showed decrease in urinary leakage volume and incontinence degree score. PFMT: pelvic floor muscle training. **indicated that a statistically significant difference was found in comparison between two groups ($P < 0.05$).

Physiologic indicators

Urodynamic indicators: Prior to treatment, there were no significant differences observed in VLPP, MUCP, MUP, BC, FUL, MCC, or PdetQmax between the two groups (all $P > 0.05$). After treatment, these indexes remained unchanged in the PFMT group (all $P > 0.05$), whereas the combined treatment group exhibited significant improvements across all urodynamic indicators ($P < 0.05$) (**Table 4**). This finding suggested that the combined treatment helps to improve the physiological function of the urinary system, which contributes to its superior efficacy in treating PSUI.

Pelvic floor muscle strength and electromyogram: After treatment, both groups showed improved pelvic floor muscle strength, whereas the combined treatment group had a higher level at different time points ($P < 0.05$) (**Table 5**). Similarly, the electromyogram of pelvic floor muscles increased in both groups post-treatment, while the combined treatment group showed a significantly greater increase ($P < 0.05$) (**Table 6**). These results show that the combined treatment is more effective in strengthening pelvic floor muscles, which is a key factor in improving urinary incontinence.

Secondary outcomes: sexual function and psychological well-being

Sexual quality of life: The combined treatment group had significantly better scores on sex life compared to the PFMT group ($P < 0.05$) (**Table 7**).

Negative emotion: Before treatment, there were no significant differences in SAS and SDS scores between the two groups ($P > 0.05$). After treatment, both groups showed a reduction in negative emotion scores, but the combined treatment group showed significantly greater decrease, with lower SAS and SDS scores compared to the PFMT group ($P < 0.05$) (**Table 8**). This suggested that the combined treatment not only improved physical symptoms but also had a positive impact on patients' psychological well-being.

Discussion

Postpartum SUI (PSUI) is a common complication after childbirth, with an incidence of approximately 23%-40% within the first four months postpartum [18]. Given its significantly negative effect on postpartum recovery and quality of life, it is crucial to explore an effective treatment. Early rehabilitation interventions, such as PFMT, help to promote pelvic floor muscle recovery and reduce recurrence. Acupuncture, as a traditional intervention, is also recognized for strengthening pelvic floor muscles and improving bladder function. Therefore, investigating the efficacy of combining acupuncture with PFMT for PSUI management is necessary and warranted.

To explore the factors underlying the enhanced efficacy of combined therapy, a comprehensive comparison with existing literature is warranted. Previous studies have investigated the benefits of either acupuncture or PFMT alone in managing SUI. For instance, a randomized con-

Table 4. Comparison of urodynamic indexes ($\bar{x}$±s)

Urodynamic indexes	Phrase	PFMT group (n = 45)	Combined treatment Group (n = 52)	t	*P*
VLPP (kPa)	before treatment	8.46±2.25	8.27±2.46	0.395	0.694
	after treatment	9.26±2.58	13.11±3.12[a]	6.560	< 0.001
MUCP (kPa)	before treatment	6.25±1.53	6.32±1.59	0.220	0.826
	after treatment	7.08±1.64	8.22±1.38[a]	3.718	< 0.001
MUP (kPa)	before treatment	6.86±2.02	6.93±2.10	0.167	0.868
	after treatment	7.39±1.28	9.28±1.54[a]	6.512	< 0.001
BC (mL/kPa)	before treatment	375.26±108.31	381.02±110.06	0.259	0.796
	after treatment	383.16±104.39	438.22±120.28[a]	2.389	0.019
FUL (mm)	before treatment	28.03±7.52	28.10±8.07	0.044	0.965
	after treatment	29.41±8.27	34.36±10.58[a]	2.538	0.013
MCC (mL)	before treatment	261.42±63.30	258.56±65.33	0.218	0.828
	after treatment	281.25±58.69	322.42±80.25[a]	2.845	0.005
PdetQmax (kPa)	before treatment	4.15±1.18	4.12±1.25	0.2010.121	0.841
	after treatment	4.63±1.12	5.36±1.50[a]	2.681	0.009

[a]means compared with before treatment in the group, $P < 0.05$. PFMT: pelvic floor muscle training; VLPP: Valsalva leak point pressure; MUCP: maximum urethral closure pressure; MUP: maximum urethral pressure; BC: bladder compliance; FUL:functional urethral length; MCC: maximum cystometric capacity; PdetQmax: detrusor pressure at maximum urine flow rate.

Table 5. Level of pelvic floor muscle strength between PFMT group vs. combined treatment group [n (%)]

Time	PFMT group (n = 45)	Combined treatment Group (n = 52)	χ^2	*P*
Upon discharge			8.026	0.007
Level I	41 (91.11)	35 (67.31)		
Level II-III	4 (8.89)	15 (28.85)		
Level IV-V	0 (0.00)	2 (3.85)		
6 weeks after treatment			62.566	< 0.001
Level I	24 (53.33)	1 (1.92)		
Level II-III	20 (44.44)	19 (36.54)		
Level IV-V	1 (2.22)	32 (61.54)		
12 weeks after treatment			59.739	< 0.001
Level I	13 (28.89)	0 (0.00)		
Level II-III	27 (60.00)	8 (15.38)		
Level IV-V	5 (11.11)	44 (84.62)		

PFMT: pelvic floor muscle training.

trolled trial by Zhu et al. [19] demonstrated that PFMT alone improved pelvic floor muscle strength and reduces urinary leakage in postpartum women, aligning with PFMT groups' findings in this study. Our study extends the existing evidence by demonstrating that acupuncture combined with PFMT yields significantly greater improvements across multiple outcomes, including a lower rate of positive cases, reduced urination symptom scores, increased overall efficacy, and enhanced pelvic floor muscle function. These results are consistent with findings from previous studies [20, 21].

PSUI typically arises from labor-induced stretching of pelvic floor muscles, ligaments, and fascia, impairing pelvic floor structure and function. Normal urine control function relies on intact periurethral structures, including the

Table 6. Comparison of electromyogram of pelvic floor muscle ($\bar{x}\pm s$)

Time	PFMT group (n = 45)	Combined treatment Group (n = 52)	t	*P*
Before treatment	19.42±1.48	19.55±1.52	0.425	0.672
After treatment	30.18±1.24	41.83±1.16	47.770	< 0.001
t	37.380	84.030	-	-
P	< 0.001	< 0.001	-	-

PFMT: pelvic floor muscle training.

Table 7. Sexual quality of life between PFMT group vs. combined treatment group [n (%)]

Sexual quality	PFMT group (n = 45)	Combined treatment Group (n = 52)	χ^2/Z	*P*
Low (< 21)	19 (42.22)	11 (21.15)	5.012	0.025
Medium (21-29)	13 (28.89)	11 (21.15)	0.775	0.379
High (≥ 29)	13 (28.89)	30 (57.69)	8.110	0.004

PFMT: pelvic floor muscle training.

Table 8. Comparison of SAS and SDS scores between PFMT group vs combined treatment group ($\bar{x}\pm s$)

Scores	PFMT group (n = 45)	Combined treatment Group (n = 52)	t	*P*
SAS				
Before treatment	52.35±8.25	52.47±7.89	0.073	0.942
After treatment	48.32±6.64[b]	40.23±5.57[b]	6.526	< 0.001
SDS				
Before treatment	54.22±6.28	54.38±6.15	0.122	0.903
After treatment	42.39±5.58[b]	38.69±5.27[b]	3.476	< 0.001

[b]means compared with before treatment in the group, $P < 0.05$. PFMT: pelvic floor muscle training; SAS: self-rating anxiety scale; SDS: self-rating depression scale.

sphincter and bladder neck [22], which maintain pelvic pressure balance. Damage to these structures disrupts pressure transmission within the pelvis. Consequently, increased abdominal pressure is not adequately transmitted to the bladder and urethra, predisposing to SUI.

In terms of physiologic mechanisms, previous research by MacDonald et al. [23] reported that acupuncture can enhance bladder function and pelvic floor muscle tone by stimulating the release of endogenous opioids and neurotransmitters, modulating the autonomic nervous system. This neurophysiologic action may explain the additional benefits observed in acupuncture when combined with PFMT. Our data revealed significantly greater improvements in urodynamic indexes (e.g., VLPP, MUCP) in the combined treatment group compared to PFMT alone. This aligns with a meta-analysis by Dai et al. [24], which concluded that acupuncture optimizes urodynamic indicators by promoting blood circulation and tissue repair in the pelvis. Moreover, well-established evidence [25, 26] supports PFMT's role in strengthening pelvic floor muscles through targeted muscle contractions. The combination likely fosters a more robust mechanism for restoring pelvic floor integrity and urinary control.

Studies have revealed that timely rehabilitation helps to improve PSUI symptoms by restoring pelvic floor muscle function [27]. Our results corroborate this, showing post-treatment levels of VLPP, MUCP, MUP, BC, FUL, MCC, and PdetQmax were significantly higher in the combined treatment group than those of the PFMT group. This indicates combining acupuncture with PFMT enhances urodynamic indicators in SUI patients. Previous studies have shown that

PFMT can enhance the urodynamic indicators of PSUI patients [28], and our study reached the same conclusion.

During the PSUI training, patients were guided to perform PFMT to strengthen their pelvic floor muscles and urethral sphincter contractility, thus reducing urinary leakage [29]. This training can thicken muscle fibers and strengthen the pelvic floor muscles, thus promoting rapid recovery of muscle and nerve function. This recovery better supports the pelvic organs and pelvic floor muscle groups, increasing the urethral pressure during exertion, thus effectively improving the urination control [30]. Additionally, PFMT can stimulate the regeneration of nerve fibers in surrounding tissues, thereby aiding neurological reflex restoration [31]. Acupuncture complements PFMT by promoting blood circulation and qi flow, improving periurethral tissue and the urethral sphincter. Consequently, it improves the nutrition of local tissues, promotes the regeneration of muscle and nerve tissues, restores bladder function, reduces urinary leakage, and ultimately enhances the therapeutic effect. Acupuncture combined with PFMT can further enhance the pelvic floor muscle function of patients [32]. This synergistic effect likely stems from the complementary mechanisms of the two interventions.

Regarding quality of life, a study by Hagenbeck et al. [33] highlighted the strong correlation between pelvic floor dysfunction and sexual dysfunction in postpartum women. We found that the combined treatment group had a significantly higher quality of sexual life, which aligns with Zhang et al. [34], who reported that enhanced pelvic floor muscle strength through integrated therapies positively influences sexual function. Moreover, the reduction in negative emotions (lower SAS and SDS scores) in the combined treatment group corresponds to Xu et al.'s longitudinal study [35], demonstrating that comprehensive interventions for SUI alleviated psychological distress in patients.

This research also revealed that the combined treatment group showed a lower rate of low quality of sex life and a higher rate of high quality of sex life compared to the PFMT group, indicating that patients receiving the combined therapy experienced better sex life after treatment. This was consistent with the results of other research [36]. The synergistic effect of acupuncture and PFMT significantly improves patients' pelvic floor muscles, thereby improving sexual quality of life. Notably, both SUI and sexual dysfunction are common clinical manifestations of postpartum pelvic floor impairment. Research at home and abroad indicates that persistent sexual dysfunction adversely affects the marital relationships and patient psychology, increasing susceptibility to negative emotions, such as anxiety and depression [37, 38]. Our study showed significantly reduced SAS and SDS scores in SUI patients after receiving combined treatment, confirming its positive psychological benefit.

This study explored the effect of acupuncture combined with PFMT on treating PSUI based on patient data. With the combined treatment, patients' symptoms of urinary incontinence, pelvic floor muscle strength, and sexual quality of life were significantly improved, and the overall efficacy was increased. This indicates that acupuncture combined with PFMT therapy has advantages for treating PSUI, which highlights its potential for comprehensive treatment.

Limitations in this study include: (1) The study was limited by a relatively small sample size, which may affect the generalizability of the findings. (2) The observation period of this study was relatively short, and no follow-ups were conducted to evaluate long-term efficacy and recurrence rate. (3) The absence of control for confounding variables may introduce bias in the results. Therefore, a variety of data mining methods should be adopted in future clinical research to make the results more reliable.

Conclusion

Acupuncture combined with PFMT demonstrated significant clinical efficacy for treating PSUI, which effectively alleviated symptoms of urinary incontinence, enhanced pelvic floor muscle strength, and improved postpartum sexual function. Given its comprehensive therapeutic benefits and high clinical applicability, this combined treatment deserves broader clinical implementation.

Disclosure of conflict of interest

None.

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References

[1] Falah-Hassani K, Reeves J, Shiri R, Hickling D and McLean L. The pathophysiology of stress urinary incontinence: a systematic review and meta-analysis. Int Urogynecol J 2021; 32: 501-552.

[2] Wu X, Zheng X, Yi X, Lai P and Lan Y. Electromyographic biofeedback for stress urinary incontinence or pelvic floor dysfunction in women: a systematic review and meta-analysis. Adv Ther 2021; 38: 4163-4177.

[3] He Y, Liu L, Dong W, Luo H, Yang Y, Ning G and Xiao Y. Evaluation of the curative effect of the combination of warm acupuncture and pelvic floor muscle exercise in female stress urinary incontinence by real-time three-dimensional pelvic floor ultrasound. Journal of Clinical Ultrasound in Medicine 2018; 20: 823-825.

[4] Brennen R, Frawley HC, Martin J and Haines TP. Group-based pelvic floor muscle training for all women during pregnancy is more cost-effective than postnatal training for women with urinary incontinence: cost-effectiveness analysis of a systematic review. J Physiother 2021, 67: 105-114.

[5] Nambiar AK, Arlandis S, Bø K, Cobussen-Boekhorst H, Costantini E, de Heide M, Farag F, Groen J, Karavitakis M, Lapitan MC, Manso M, Arteaga SM, Riogh ANA, O'Connor E, Omar MI, Peyronnet B, Phé V, Sakalis VI, Sihra N, Tzelves L, van Poelgeest-Pomfret ML, van den Bos TWL, van der Vaart H and Harding CK. European Association of Urology Guidelines on the Diagnosis and Management of Female Non-neurogenic Lower Urinary Tract Symptoms. Part 1: diagnostics, overactive bladder, stress urinary incontinence, and mixed urinary incontinence. Eur Urol 2022; 82: 49-59.

[6] Shi H, Zhao L, Cui L, Wang Z, Wang D, Liu P, Si G, Guo D and Liu W. A critical overview of systematic reviews and meta-analyses of acupuncture for female stress urinary incontinence. Pain Res Manag 2022; 2022: 5887862.

[7] Chen M. Observation on therapeutic effect of acupuncture and moxibustion regulating Ren and Du meridians on female stress urinary incontinence. Modern Journal of Integrated Traditional Chinese and Western Medicine 2020; 29: 1517-1521.

[8] Hongliang Y, Pengfei L, Cuiping J, Jieqian H, Ling P and Yumin S. Pelvic floor function and morphological abnormalities in primiparas with postpartum symptomatic stress urinary incontinence based on the type of delivery: a 1:1 matched case-control study. Int Urogynecol J 2022; 33: 245-251.

[9] Mikuš M, Kalafatić D, Vrbanić A, Šprem Goldštajn M, Herman M, Živković Njavro M, Živković K, Marić G and Ćorić M. Efficacy comparison between kegel exercises and extracorporeal magnetic innervation in treatment of female stress urinary incontinence: a randomized clinical trial. Medicina (Kaunas) 2022; 58: 1863.

[10] Fajar Marta K and Moegni F. Level of agreement and acceptance of the 20-minute versus 60-minute sanitary pad test as a method for measuring the severity of stress urinary incontinence: randomised crossover trial. J Obstet Gynaecol 2022; 42: 1251-1254.

[11] Tong Y and Yao L. Clinical study on prevention of postpartum urinary incontinence by acupuncture and moxibustion combined with early pelvic floor muscle rehabilitation training. Chinese Journal of Information on Traditional Chinese Medicine 2019; 26: 43-45.

[12] Xu M, Zhang X, Zhuo Y, Wu W, Liu Q, Qin S, Long Z, Ai K, Li Y and Zhang H. Health Qigong Mawangdui Guidance can improve pelvic floor muscle function and quality of life in females with stress urinary incontinence: a randomized controlled trial pilot study. Medicine (Baltimore) 2024; 103: e37671.

[13] Liu Z, Liu Y, Xu H, He L, Chen Y, Fu L, Li N, Lu Y, Su T, Sun J, Wang J, Yue Z, Zhang W, Zhao J, Zhou Z, Wu J, Zhou K, Ai Y, Zhou J, Pang R, Wang Y, Qin Z, Yan S, Li H, Luo L and Liu B. Effect of electroacupuncture on urinary leakage among women with stress urinary incontinence: a randomized clinical trial. JAMA 2017; 317: 2493-2501.

[14] Fürst MC, Mendonça RR, Rodrigues AO, Matos LL, Pompeo AC and Bezerra CA. Long-term results of a clinical trial comparing isolated vaginal stimulation with combined treatment for women with stress incontinence. Einstein (Sao Paulo) 2014; 12: 168-74.

[15] Daescu AC, Dehelean L, Navolan DB, Pop GN and Stoian DL. Psychometric properties of the Romanian version of the female sexual function index (FSFI-RO). BMC Womens Health 2023; 23: 528.

[16] Rapp DE, Hutchison D, Jones MK, DeNovio A and Greene KL. Novel online comprehensive pelvic floor therapy program following prostatectomy. Transl Androl Urol 2023; 12: 1775-1784.

[17] Naumann G, Huebner M, Taran FA, Tunn R, Reisenauer C and Neis F. Surgical procedures for the treatment of Stress Urinary Incontinence (SUI) in the light of the updated FDA-warning and its effects on practice patterns in germany between 2010 and 2021. Geburtshilfe Frauenheilkd 2024; 84: 256-263.

[18] Zhang C. Effect of pelvic floor rehabilitation training combined with acupuncture on postpartum stress urinary incontinence and pelvic floor muscle strength. Maternal & Child Health Care of China 2018; 33: 1975-1978.
[19] Zhu H, Zhang D, Gao L, Liu H, Di Y, Xie B, Jiao W and Sun X. Effect of pelvic floor workout on pelvic floor muscle function recovery of postpartum women: protocol for a randomized controlled trial. Int J Environ Res Public Health 2022; 19: 11073.
[20] Fu X and Chen Y. Effect of warm acupuncture combined with pelvic floor muscle exercise on early postpartum stress urinary incontinence and its influence on coagulation function. Chinese Journal of Thrombosis and Hemostasis 2021; 27: 941-942.
[21] Sun L and Wei Z. Acupuncture and rehabilitation therapy combined with pelvic floor muscle exercise in treatment of early postpartum stress urinary incontinence. Liaoning Journal of Traditional Chinese Medicine 2017; 44: 828-830.
[22] Xu M, Zhang W, Sheng L, Hu M and Xu X. Biomimetic urine flow control can preserve bladder function in patients with indwelling catheterization. Medicine (Baltimore) 2023; 102: e36444.
[23] MacDonald IJ and Chen YH. The endocannabinoid system contributes to electroacupuncture analgesia. Front Neurosci 2021; 14: 594219.
[24] Dai J, Zhang X, Lian F, Li H, Tu J, Chen Y and Jin Z. Clinical study on improving the function of female bladder in controlling urine by acupuncture Zhibian (BL54) under ultrasound guidance. World J Urol 2024; 42: 300.
[25] De Marco M, Arbieto ERM, Da Roza TH, Resende APM and Santos GM. Effects of visceral manipulation associated with pelvic floor muscles training in women with urinary incontinence: a randomized controlled trial. Neurourol Urodyn 2022; 41: 399-408.
[26] Ninomiya S, Okayama H, Naito K and Morikawa S. Effects of unsupervised gluteal muscle contraction versus unsupervised pelvic floor muscle training in women with symptoms of stress urinary incontinence: a randomized controlled trial. Int Urogynecol J 2024; 35: 1829-1837.
[27] Wang X, Sun Z, Xu T and Fan G. Efficacy of supervised pelvic floor muscle training with a home-based biofeedback device for urinary incontinence in postpartum women: protocol for a multicentre randomised controlled trial. BMJ Open 2023; 13: e069874.
[28] Tsikopoulos I, Lazarou L, Tzelves L, Sakalis V, Papathanasiou C and Samarinas M. The effect of pelvic floor muscle training on urodynamic parameters in women with stress urinary incontinence. Cent European J Urol 2023; 76: 315-321.
[29] Chu L, Jin X, Wu S, Tong X, Li H and Chen X. Effect of pelvic floor muscle training with smartphone reminders on women in the postpartum period: a randomized controlled trial. Urogynecology (Phila) 2024; 30: 138-146.
[30] Hagovska M and Svihra J. Evaluation of duloxetine and innovative pelvic floor muscle training in women with stress urinary incontinence (DULOXING): study protocol clinical trial (SPIRIT compliant). Medicine (Baltimore) 2020; 99: e18834.
[31] Han H and Li M. Effect of acupuncture on postpartum stress urinary incontinence. Chinese Journal of Rehabilitation Theory and Practice 2011; 17: 671-672.
[32] Zhang X, Fan Y, Wang Q, Yao Q and Jin Z. Efficacy comparison between electroacupuncture pudendal nerve stimulation and normal electroacupuncture in treating postpartum stress urinary incontinence. Shanghai Journal of Traditional Chinese Medicine 2021; 55: 45-49.
[33] Hagenbeck C, Kössendrup J, Soff J, Thangarajah F and Scholten N. Pelvic floor-related sexual functioning in the first 24 months postpartum: findings of a large cross-sectional study. Acta Obstet Gynecol Scand 2025; 104: 203-214.
[34] Zhang JT, Ma L, Gong X, Luo S and Zhao S. Clinical study on the use of acupuncture for the treatment of female sexual dysfunction: a pilot study. Sex Med 2022; 10: 100541.
[35] Xu Z, Zhang X, Shi H, Liang M, Ning F, Wang Q and Jia H. Efficacy of acupuncture for anxiety and depression in functional dyspepsia: a systematic review and meta-analysis. PLoS One 2024; 19: e0298438.
[36] Zhou Y, Aynur A, He Y, Yuan H and Zhou H. Effects of sacral four-needle therapy combined with pelvic floor muscle exercise on pelvic floor function and sexual quality of patients with postpartum stress urinary incontinence. Chinese Journal of Human Sexuality 2022; 31: 134-137.
[37] Reis AM, Brito LGO, Lunardi ALB, Pinto E Silva MP and Juliato CRT. Depression, anxiety, and stress in women with urinary incontinence with or without myofascial dysfunction in the pelvic floor muscles: a cross-sectional study. Neurourol Urodyn 2021; 40: 334-339.
[38] Zuluaga L, Caicedo JI, Mogollón MP, Santander J, Bravo-Balado A, Trujillo CG, Diaz Ritter C, Rondón M and Plata M. Anxiety and depression in association with lower urinary tract symptoms: results from the COBaLT study. World J Urol 2023; 41: 1381-1388.