

Systematic Review

Effectiveness of Laser Therapy in Stress Urinary Incontinence Patients: A Systematic Review and Meta-Analysis

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Abstract

Objective: This systematic review and meta-analysis aimed to evaluate the effectiveness of laser therapy in improving urinary and sexual function in women with SUI.

Methods: The literature was selected using the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) protocol. We did literature searches in several databases, including Science Direct, Pubmed, Google Scholar, Cochrane, ProQuest, and Scopus, from inception until January 2025. Quality assessment was performed using the Cochrane Risk of Bias Tool. Mean differences (MD) with 95% confidence intervals (CI) were calculated using a random-effects model.

Result: There were ten journals with 598 participants that met the criteria. The results of the pooled analysis showed a statistically significant improvement in post-laser therapy pad weight (MD = -0.49; 95% CI: -0.97 to -0.01; $p = 0.0435$). Despite the non-significant differences and heterogeneity found in the meta-analysis of sexual function outcome (MD = -0.49; 95% CI: -0.97 to -0.01; $p = 0.0435$), the individual studies stated that the sexual function was improved in women with SUI post-laser therapy.

Discussion: Laser therapy, particularly CO₂ and Er:YAG modalities, appears effective in enhancing sexual function in women with SUI. Variability in protocols and outcome measures among studies may contribute towards heterogeneity. Most trials had small sample sizes and short follow-ups.

Conclusion: Laser therapy shows promise for improving urinary and sexual function in women with SUI, warranting further robust research.

Key words: ICIQ-UI SF; laser therapy; pad weight; PISQ-12; sexual function; stress urinary incontinence

Efektivitas Terapi Laser pada Pasien Inkontinensia Urin Stres: Tinjauan Sistematis dan Meta-Analisis

Abstrak

Tujuan: Tinjauan sistematis dan meta-analisis ini bertujuan untuk mengevaluasi efektivitas terapi laser dalam meningkatkan fungsi urinasi dan seksual pada wanita dengan SUI.

Metode: Literatur diseleksi dengan protokol *Preferred Reporting Items for Systematic Review and Meta-analyses* (PRISMA). Penelusuran literatur dilakukan pada beberapa basis data, termasuk *Science Direct*, *Pubmed*, *Google Scholar*, *Cochrane*, *ProQuest*, dan *Scopus*, sejak awal hingga Januari 2025. Penilaian kualitas dilakukan menggunakan *Cochrane Risk of Bias Tool*. *Mean differences* (MD) dengan interval kepercayaan (CI) 95% dihitung menggunakan model efek acak.

Hasil: Terdapat sepuluh jurnal dengan 598 partisipan yang memenuhi kriteria. Hasil penelitian dari analisis gabungan menunjukkan bahwa terdapat peningkatan yang signifikan secara statistik pada pad weight pasca terapi laser (MD = -0,49; 95% CI: -0,97 hingga -0,01; $p = 0,0435$). Meskipun perbedaan dan heterogenitas yang tidak signifikan ditemukan dalam meta-analisis hasil fungsi seksual (MD = -0.49; 95% CI: -0.97 to -0.01; $p = 0.0435$), studi individual menyatakan bahwa fungsi seksual membaik pada wanita dengan SUI pasca-terapi laser.

Diskusi: Terapi laser, khususnya modalitas CO₂ dan Er:YAG, tampak efektif dalam meningkatkan fungsi seksual pada wanita dengan SUI. Variabilitas dalam protokol dan ukuran hasil di antara studi dapat berpengaruh pada heterogenitas. Sebagian besar uji coba memiliki ukuran sampel kecil dan *follow-up* yang singkat.

Kesimpulan: Terapi laser menunjukkan harapan untuk meningkatkan fungsi urin dan seksual pada wanita dengan SUI, yang menjamin penelitian lebih lanjut yang kuat.

Kata kunci: Fungsi seksual; ICIQ-UI SF; inkontinensia urin stress; *pad weight*; PISQ-12; terapi laser

Introduction

The condition of involuntary urine loss is known as urinary incontinence, which is found to be not uncommon in females. The most prevalent group is the stress urinary incontinence (SUI), which is characterised by spontaneous loss linked to physical exertion that raises intra-abdominal pressure when intravesical pressure exceeds urethral pressure due to a malfunction in urethral resistance mechanisms. Apart from SUI, two other types of urinary incontinence are among the most common: urgent urine incontinence (UII) and mixed urinary incontinence (MUI).^{1,2}

A patient's quality of life may be greatly impacted by female SUI that affects between 26% and 49% of women. Increased stomach pressure causes the urethra to be unable to adequately oppose the flow of urine, which leads to SUI. Ageing, number of births, Caucasian race, smoking, thyroid dysfunction, lung disease, obese person, diabetes mellitus, and a family history of SUI are common risk factors for SUI. Urinary incontinence is rarely fatal to patients' lives, but its association with sexual dysfunction, anxiety, despair, social isolation, and employment impairment has been made. Women's sexuality is significant during various phases of their lives. Resignation from sexual intercourse is frequently caused by the fear of urine leaking itself.^{3,4}

Patients can be managed by several kinds of management, including conservative management. Pelvic floor muscle training necessitates a high degree of patient compliance since results require consistent, long-term, and proper exercise performance. Surgical management can also be offered to the patients. Although there are many successful surgical techniques, they are associated with a high rate of complications and recovery time.^{5,6} Female SUI can be effectively treated and managed with laser

therapy, which is a less invasive therapeutic approach. Fibroblasts are physiologically stimulated to form new collagen fibres as a result of the regulated thermal damage created during therapy, which also produces a strong wound healing response.^{7,8} There are currently three distinct laser modalities available for treating SUI: dual-phase erbium-doped yttrium aluminium garnet (Er:YAG) laser therapy (2,940 nm) that combines fractional cold ablation and thermal ablation; non-ablative Er:YAG laser therapy (2,940 nm) with SMOOTH mode technology; and microablative fractional carbon dioxide (CO₂) laser therapy (10,600 nm).^{9,10} The studies that evaluate the effect of these treatments has shown varying results in urinary incontinence outcome as well as in sexual function, as measured by questionnaires and tests, such as pad weight test, International Consultation on Incontinence Questionnaire-Urinary Incontinence Short Form (ICIQ-UI SF), Pelvic Organ Prolapse/Urinary Incontinence Sexual Questionnaire (PISQ-12), and Female Sexual Function Index (FSFI). Thereby, this research is intended to assess the effectiveness of laser therapy in improving urinary function and sexual function among patients with stress urinary incontinence.

Methods

Searching Strategy

We searched six databases (Science Direct, Pubmed, Google Scholar, Cochrane, ProQuest, and Scopus) from inception until January 31, 2025. We developed three main concepts, namely "laser therapy", "sexual function", and "stress urinary incontinence" as a guide to expand the medical subject headings (MeSH) and keywords for each database. All MeSH and keywords in the same concept were conjoined by employing the Boolean operator "OR". After that, those two concepts were put together by utilizing

the Boolean operator “AND”.

Article Selection

Two reviewers screened the retrieved studies based on the title as well as the abstract, separately. Full-text articles were obtained for all studies that were judged to be possibly relevant. Both reviewers also assessed the full article before deciding to include the articles, using predefined inclusion and exclusion criteria. Since a conflict arose between those two reviewers, discussion through a third reviewer was conducted. All phases of this process were conducted using the Rayyan platform for the study selection process.

We included all studies that met all of the following criteria: 1) Studies with adult women diagnosed with stress urinary incontinence; 2) Studies with adult women treated with laser therapy; and 3) Studies with designs: randomized clinical trials and observational studies. We excluded studies that met any of the following criteria: 1) Studies with designs: case report, abstract, editorial, and letter; 2) Studies with missing data; and 3) Study with unvalidated instruments for the assessment of sexual function.

Data Extraction

Two independent authors extracted data from each included study. The third reviewer helped resolve any disagreements. From each eligible study, the following data were extracted for study characteristics: 1) author; 2) population; 3) intervention; 4) comparator; 5) outcome measure; 6) assessment tool; 7) follow-up duration; 8) findings; and 9) adverse events.

Risk of Bias Assessment

Each study's quality was evaluated by employing the RoB 2.0 tool. This tool consisted of five domains, and each domain

can be answered as low, some concern, or high risk of bias.

Statistical Analysis

We did a meta-analysis by performing it in RStudio. We employed a random-effects model to summarize the outcome in summary measures of mean differences. Mean and standard deviation were obtained for corresponding variables. Since no standard deviation was found, the 95% confidence intervals were obtained to calculate the standard deviation. Heterogeneity was assessed by calculating the I^2 . A forest plot was created to visualize the summary results for each variable. A statistically significant result was deemed upon having the p-value below 0.05.

Results

Article Selection

The initial literature search resulted in 682 articles from six databases. We searched for the duplicates and removed 158 duplicates. Afterwards, the subsisting 524 articles were screened, which resulted in 18 articles sought for retrieval. Four articles cannot be retrieved, and as a result, a total of 14 articles were evaluated according to the eligibility criteria we created. As many as 4 articles were measuring different variables; therefore, we included 10 studies in our review. **(Figure 1).**

Baseline Characteristics and Evaluation of Risk of Bias

Our review comprises of five randomized controlled trials and five cohort studies. All of the studies included women with SUI. Seven articles used Er:YAG laser, two used the fractional CO₂, whilst the one remaining study used radiofrequency and hybrid fractional laser as the intervention for SUI.

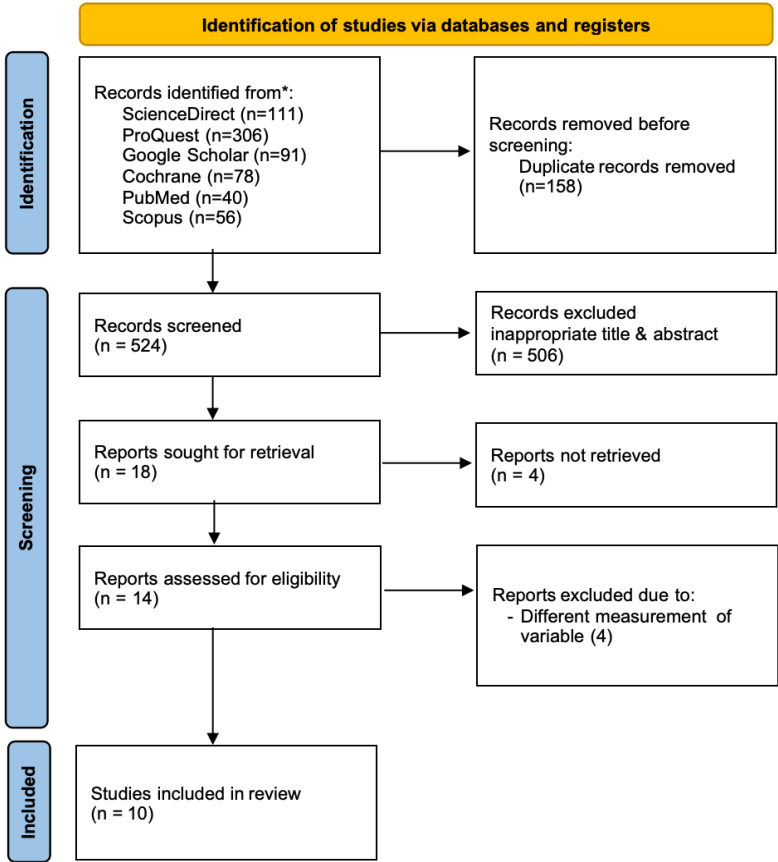


Figure 1 PRISMA Flow Diagram

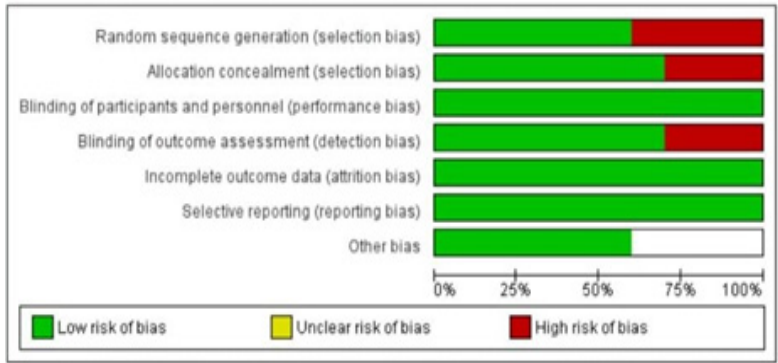


Figure 2 Assessment of Risk of Bias

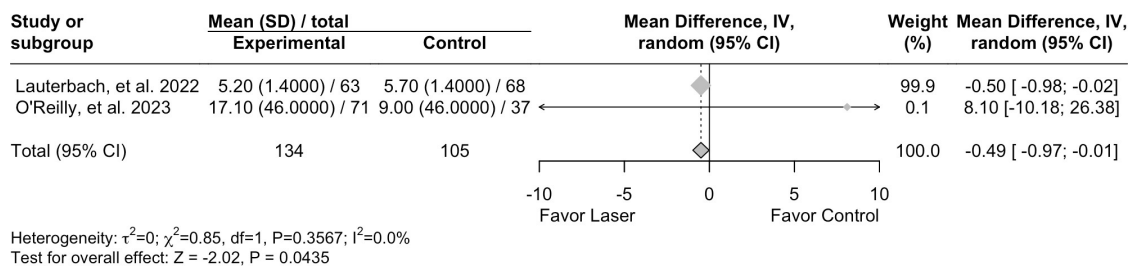


Figure 3 Forest Plot of The Pooled Mean Difference of The Pad Weight Test After Interventions Using Laser or Sham

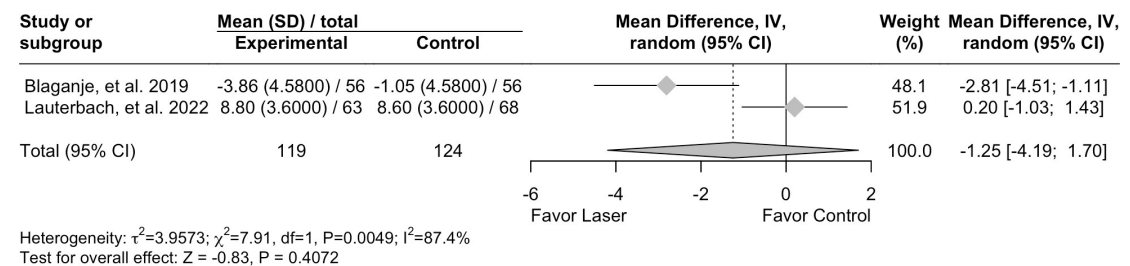


Figure 4 Forest Plot of The Pooled Mean Difference of ICIQ-UI SF After Interventions Using Laser or Sham

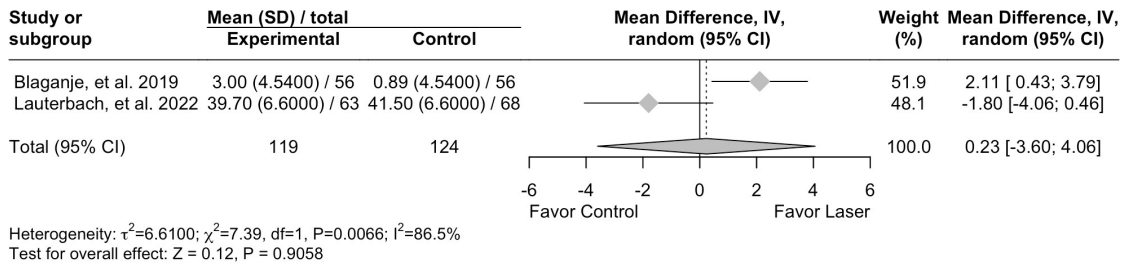


Figure 5 Forest Plot of The Pooled Mean Difference of PISQ-12 After Interventions Using Laser or Sham

Most of the studies only had a single arm, which means they had no other interventions to be compared to. The follow-up duration from all of the studies ranged from four weeks to two years (Table 1). Furthermore, most of the domains of the risk of bias assessment had a low risk, except for random sequence generation, allocation concealment, and blinding of outcome assessment which showed high risk for some studies (Figure 2).

Pad Weight

The pooled mean difference of the pad weight test showed a result of -0.49 (95% CI = - 0.97 to -0.01; $p = 0.0435$) with $I^2 = 0.0\%$ and

$p_{\text{heterogeneity}} = 0.3567$ (Figure 3). These results showed that the pad weight was significantly lower, thereby better results, in the population that used lasers compared to the control group with no heterogeneity found between groups.

ICIQ-UI SF

The pooled mean difference of ICIQ-UI SF showed a result of -1.25 (95% CI = -4.19 to 1.70; $p = 0.4072$) with $I^2 = 87.4\%$ and $p_{\text{heterogeneity}} = 0.0049$ (Figure 4). These results showed that the ICIQ-UI was not significantly different between the population that used lasers compared to the control group, with high heterogeneity found between groups.

Table 1 Baseline Characteristics of Included Studies

Author(s)	Population	Intervention	Comparator	Outcome Measure	Assessment Tool	Follow-Up Duration	Findings	Adverse Event
Cheng-Yu Long et al., 2022	50 women with stress urinary incontinence (SUI)	Er:YAG vaginal laser (2940 nm) treatment	None	Changes in vaginal topography, SUI improvement, sexual function	3D transperineal ultrasound, FSFI	6 months	Significant vaginal shrinkage, 74% improvement in SUI; significant improvement in FSFI scores except for desire	None reported
Yi-Hao Lin et al., 2017	30 women with urodynamic stress incontinence (USI) and overactive bladder (OAB)	Er:YAG laser (Smooth Mode, 2940 nm)	None	Improvement in UI, OAB symptoms, sexual function	Urological questionnaires (OABSS, ICIQ-SF, UDI-6, PISQ-12)	3, 12 months	Significant improvement in UI and sexual gratification at 3 months but diminished by 12 months	Mild pain, vaginal discharge, spotting
Yi-Wen Tien et al., 2016	35 women with USI symptoms	IncontiLase™ (Er:YAG laser)	None	Changes in pad weight, urodynamic symptoms, LUTS, sexual function	Pad weight test, FSFI, King's Health Questionnaire	6 months	Pad weight reduced significantly, 39.3% objective cure rate; improvement in	None reported
Wamsley et al., 2022	31 postmenopausal women with vulvovaginal symptoms	Radiofrequency (RF) and Hybrid Fractional Laser (HFL)	Placebo	Symptom improvement, vaginal laxity, gene expression changes	VSQ, VLQ, UDI-6, IIQ, FSFI, vaginal biometric analysis	6 months	FSFI desire domain significantly improved in VSQ, VLQ, IIQ, and FSFI scores in HFL and dual treatment groups	Not reported
O'Reilly et al., 2024	110 women with urodynamically confirmed SUI	Vaginal Er:YAG laser therapy	Sham handpiece	Pad weight test, SUI severity, sexual function, HRQoL	1-hour pad test, ICIQ-UI SF, PISQ-12, KHQ, PGI-I	12 months	Er:YAG laser significantly improved SUI symptoms and QoL compared to sham; significant improvement in PISQ-12 scores	No serious adverse events reported

Author(s)	Population	Intervention	Comparator	Outcome Measure	Assessment Tool	Follow-Up Duration	Findings	Adverse Event
Lauterbach et al., 2022	131 women with prior successful laser treatment for SUI	Single maintenance CO ₂ laser treatment	Sham treatment	Cough test, pad weight test, QoL	UDI-6, ICIQ-UI, PISQ-12	6 months	Temporary PISQ-12 improvement at 3 months but returned to baseline by 6 months	No serious adverse events reported
Blaganje et al., 2018	114 sexually active women (35-65 years) with SUI	Non-ablative Er:YAG laser therapy	Sham treatment	SUI improvement	ICIQ-UI SF, FSFI	3 months	Significant improvement in SUI and sexual satisfaction; Improved FSFI scores in laser group	None reported
Palacios et al., 2018	25 women (35-68 years) with moderate to severe SUI/MUI	Fractional CO ₂ laser (CO ₂ RE Intima)	None	SUI/MUI improvement	ICIQ-IU, Sandvik Severity Index, FSFI	4-6 weeks post-treatment	Significant improvement in urinary symptoms and sexual function; Improved FSFI scores	No major adverse events reported
Toplu G, et al., 2021	30 women (average age 48.3) with vaginal laxity, sexual dysfunction, and urinary incontinence	Fractional CO ₂ laser therapy	None	Vaginal laxity, sexual satisfaction, urinary incontinence	QUID, PISQ-12	6 months	proved FSFI scores High satisfaction with improved vaginal laxity (66%) and sexual activity (63%). QUID scores significantly reduced; PISQ-12 scores remained similar.	None reported
Kuszk et al., 2019	59 women with SUI I-III	Er:YAG laser (IncontiLase protocol)	None	Cure/improve rates of SUI	1-h pad test, ICIQ-UI SF, PISQ-12	6 months, 2 years	High cure/improved rates in SUI I & II, minimal effect in SUI III; improved PISQ-12 scores	Minor adverse events, mild discomfort

PISQ-12

The pooled mean difference of PISQ-12 showed a result of 0.23 (95% CI = -3.60 to 4.06; $p = 0.9058$) with $I^2 = 86.5\%$ and $p_{\text{heterogeneity}} = 0.0066$ (**Figure 5**). These results showed that the PISQ-12 was not significantly different between the population that used lasers compared to the control group, with high heterogeneity found between groups.

Discussion

Vaginal laser therapy using Er:YAG, fractional CO₂, or a combination of radiofrequency², has been reported to provide significant improvement in urinary incontinence symptoms, particularly stress urinary incontinence (SUI), and contribute to improved sexual function and quality of life in patients.¹¹⁻²⁰ Various studies indicate that this treatment is a relatively safe modality, with side effects being mostly mild, transient, and not requiring special intervention, and no serious adverse events were observed during the reported follow-up period.^{12,15,16,18,20} Variation in assessment tools provides a more comprehensive picture of the benefits of therapy on the patients' condition.¹¹⁻²⁰

A non-invasive technique for identifying and measuring the extent of urine leakage is pad testing. In order to assess urine incontinence, pad testing is an optional procedure, according to the 4th International Consultation on Incontinence. The literature has documented a variety of testing lengths, and only the 1-hour pad test has a standardized test technique.²¹ In this study, we found that the pad weight test was significantly lower in groups of patients that were being treated by laser compared to the sham group. This result can be interpreted as the laser group having a lower severity of incontinence compared to the sham group.²² Our result also has a similarity with the result from a meta-

analysis study by Wang et al. in 2021, which was intended to assess the effectivity of laser therapy, as well as its safeness. They stated that the improvement in 1-hour pad weight test results at 1, 3, and 12 months post-treatment was -5.59 (95% CI: -6.93--4.25), -4.96 (95% CI: -6.73--3.20), and -5.82 (95% CI: -6.77--4.87), respectively.²³

The ICIQ-UI Short Form is a set of questions used in clinical settings and research worldwide to mainly assess the effect of urine incontinence on the quality of life of affected patients. General practitioners and clinicians in primary and secondary care facilities can also benefit from this brief and easy questionnaire for screening for incontinence, getting a concise but thorough overview of the severity, significance, and perceived cause of incontinence symptoms, and facilitating patient- clinician conversations.²⁴ In this study, there was no meaningful dissimilarity in ICIQ-UI SF between the laser and the control groups. We cannot assess the heterogeneity source due to the lack of studies. This result is different from the result of the study by Wang et al. They showed that after laser treatment, there were improvements in the ICIQ-SF score at 1, 2, and 6 months, which were -5.49 (95% CI: -6.74--4.24; $I^2=91\%$, $P<0.01$), -4.97 (95% CI: -6.24--3.71), and -5.48 (95% CI: -6.15--4.81), respectively.²²

It is crucial to use questionnaires to measure the alteration of quality of life in females who have urinary incontinence in order to evaluate the effectiveness of medicinal and surgical treatments. The Pelvic Organ Prolapse/Urinary Incontinence Sexual Questionnaire (PISQ-12) is a self-administered, valid, and reliable scale that was originally designed by Rogers et al. to assess sex-related activity in patients with incontinence. They then created the PISQ-12, a validated and reliable shortened version of the Pelvic Organ Prolapse/Urinary Incontinence Sexual Questionnaire that

reliably predicts long form results.²⁵ In this study, there was no meaningful dissimilarity in PISQ-12 between the laser and the control groups. We cannot assess the heterogeneity source due to the lack of studies. This result is different from the result of the study by Wang et al. They showed that the PISQ-12 score increased by 5.39 (95% CI: 1.20–9.58) following treatment.²³ However, almost all individual included studies in this review reported improvements in sexual function following laser therapy.¹¹⁻²⁰

Heterogeneity was found in the statistical analysis of this study; however, the sources of this heterogeneity could not be pinpointed in exact, as previously mentioned, due to the scarcity of the included studies; sensitivity and publication bias analyses could not be conducted. Still, we can explain several pieces of evidence that could potentially be the sources of the heterogeneity. First, the inclusion criteria for each study were different. Blaganje et al. included premenopausal women, defined as women aged 35 to 65 years old, as the participants of their study. Meanwhile, the age criteria of participants of the study by O'Reilly et al. were women over 18 years old, and those of the study by Lauterbach et al. were women between 40 and 70 years old. Second, the differing exclusion criteria may result in the exclusion of different participants. For example, pelvic organ prolapse was not a part of the exclusion criteria of the study by Lauterbach et al. Contrary to that, women with pelvic organ prolapse above grade 1 and grade 2 were excluded from the study by Blaganje et al. and O'Reilly et al., respectively. Lastly, the blinding of the involved parties was different for each study. O'Reilly et al. blinded the participants only, Blaganje et al. blinded the participants and the outcome assessor, and Lauterbach et al. blinded the participants and the person who did the intervention or the laser therapy.¹⁵⁻¹⁷

The lack of studies included in our

review was the main limitation. Due to the lack of studies, the heterogeneities could not be assessed further for the knowledge of their potential sources. Moreover, we cannot do the single-arm meta-analysis as a consequence of the absence of necessary data in the included studies. Further studies regarding the effectiveness of laser therapy in sexual function among patients with SUI are needed, presenting data that can be meta-analysed.

Conflict of Interest

We declared no conflict of interest.

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