DOI: https://doi.org/10.61841/kqfyt333 Publication URL: https://nnpub.org/index.php/MHS/article/view/2201

STRESS URINARY INCONTINENCE: A TEN YEARS SYSTEMATIC REVIEW

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ABSTRACT

Introduction*: Stress urinary incontinence (SUI) and pelvic organ prolapse (POP) affect a substantial percentage of women, significantly impacting their quality of life. This review explores the prevalence, definitions, and pathophysiology of SUI, POP, and associated urinary incontinence, emphasizing the need for medical attention and offering insights into current treatment trends over the past 5 years.*

Methods*: The researchers in this study followed the 2020 Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) guidelines to ensure that their work met the required standards. This was done to ensure the precision and reliability of the conclusions derived from the research.*

Result*: Our search produced 21 results. After looking at the titles and summaries, we found 9 papers that fit our criteria. At first, we excluded several articles because they were written in review style. But after reading the full papers carefully, we included five papers in our final analysis. These papers included a retrospective observational study, prospective study, and randomized control trial.*

Conclusion: *In this decade-long systematic review on stress urinary incontinence (SUI), notable findings include a 2.2% prevalence of SUI operations post-hysterectomy, persistent links between vaginal hysterectomy (VH) and SUI operations, and significant associations with preceding pelvic organ prolapse (POP), vaginal deliveries, laparoscopic hysterectomy (LH), and urinary incontinence (UI) visits. Combining pelvic floor muscle (PFM) strengthening with hip synergic muscle exercises improves daily urine loss frequency, while modifiable risk factors such as achieving an ideal body weight and preventing traumatic vaginal delivery are identified for SUI prevention. Cost analysis indicates that savings from avoiding unnecessary surgical treatments through urodynamic investigations (UDIs) in uncomplicated patients cover associated expenses, emphasizing the need to consider potential legal actions in a comprehensive cost assessment of negative externalities.*

Keywords: *Stress urinary incontinence, pelvic organ prolapse, urodynamic investigations*

INTRODUCTION

Stress urinary incontinence (SUI), characterized by the unintentional release of urine during physical exertion, and pelvic organ prolapse (POP), marked by the displacement of pelvic organs from their normal positions, are prevalent conditions affecting 30–40% of women throughout their lives.[1,2] Despite being non-life-threatening, these ailments impose a considerable healthcare burden on the aging population and adversely impact women's quality of life. SUI results from diminished support in the pelvic floor and vaginal connective tissue around the bladder neck and urethra, while POP stems from weakness in various layers of the endopelvic fascia and levator ani muscle complex. Concurrent occurrence of SUI in women with POP is common due to similar pathophysiology.[3]

Urinary Incontinence (UI) is a prevalent, yet often under-reported issue, as many women hesitate to seek medical advice.[3] While not life-threatening, incontinence can significantly impact the quality of life (QoL). The International Continence Society defines UI as a "complaint of involuntary leakage of urine, which poses a social or hygienic problem". According to the International Urogynecological Association (IUGA) and the International Continence Society (ICS), stress urinary incontinence (SUI) is characterized by urinary leakage in the presence of increased intra-abdominal pressure without detrusor activation.[4] Urge urinary incontinence (UUI) involves the involuntary loss of urine during detrusor activation and is indicative of overactive bladder (OAB). OAB is often accompanied or immediately preceded by urgency [2]. The simultaneous occurrence of stress and urge incontinence is termed mixed urinary incontinence (MUI).[5]

This systematic review aims to elucidate the current trends in the treatment of SUI and POP, with a specific focus on the literature regarding efficacy and complications over the past 5 years. Risk factors for both conditions encompass pregnancy, vaginal parity, forceps delivery, age, menopause, prior pelvic reconstructive surgeries, and chronic straining. Conservative management predominantly involves pelvic floor muscle training (PFMT) and vaginal pessaries, while surgical interventions may include native-tissue or mesh-based repairs through abdominal, laparoscopic, or vaginal approaches. The purpose of this review is to provide insights into the latest advancements in the treatment of SUI and POP, offering a comprehensive overview of therapeutic modalities and their associated outcomes.

METHODS

Protocol

The researchers in this study followed the 2020 Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) guidelines to ensure that their work met the required standards. This was done to ensure the precision and reliability of the conclusions derived from the research.

CRITERIA FOR ELIGIBILITY

For inclusion in the study, published articles had to meet particular requirements. They had to be research papers written in English, focusing on stress urinary incontinence. The studies had to meet the following criteria: they needed to have been published after 2018 but within the applicable timeframe for this systematic review. Articles falling into categories like editorials, lacking a DOI, review articles that were already published, or duplicating previously published journal papers were excluded from the assessment.

SEARCH STRATEGY

We conducted a comprehensive literature search using PubMed, focusing on studies published from 2014 to 2024. The search terms employed were as follows"urinary incontinence, stress"[MeSH Terms] OR ("urinary"[All Fields] AND "incontinence"[All Fields] AND "stress"[All Fields]) OR "stress urinary incontinence"[All Fields] OR ("stress"[All Fields] AND "urinary"[All Fields] AND "incontinence"[All Fields]). Moreover, we performed cross-referencing of relevant articles to reveal additional research. The evaluation of study quality, methodology, interventions, and results was undertaken independently by the researchers, resolving any differences through discussion and agreement. Furthermore, both researchers collected and compared discoveries from all studies, considering the potential for conducting a meta-analysis if deemed feasible.

INCLUSION AND EXCLUSION CRITERIA

Inclusion criteria for the studies were as follows: (1) original research that assesses stress urinary incontinence; (2) Randomized Controlled Trials (RCTs) or observational studies (cohort or case-control studies); (3) availability of relevant data. Exclusion criteria were as follows: (1) ongoing studies or studies without available data; (2) duplicate publications. In cases of duplicate publications, the most recent article was chosen; (3) Non-English language studies were excluded.

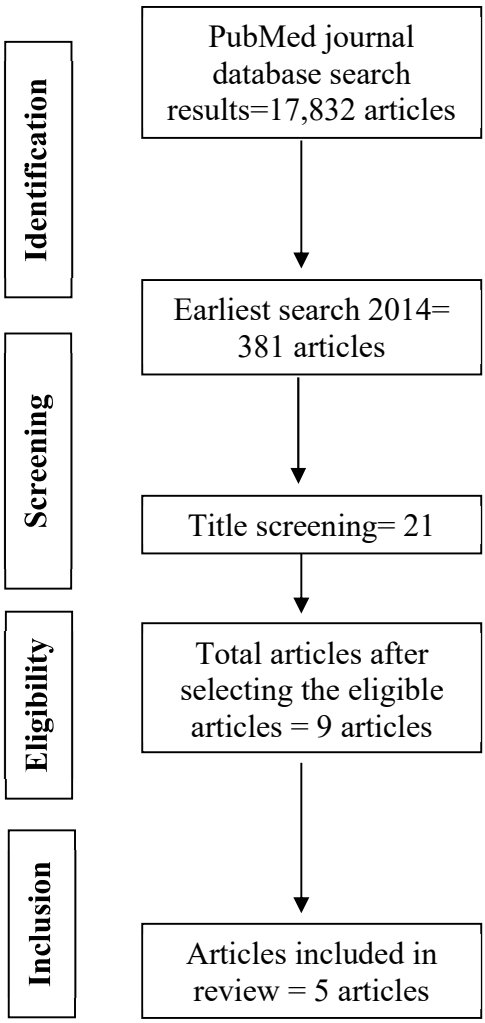

Figure 1. Article search flowchart

DATA RETRIEVAL

The authors conducted a thorough examination of relevant studies, specifically selecting those that met precise inclusion criteria. They focused on original, unpublished papers in English to ensure a refined and high-quality selection. The analysis covered essential information, such as study particulars, authors, publication dates, locations, and research methodologies, aligning with the study's objectives.

Author	Origin	Method	Sample Size	Result
Tulokas, S., et al., 2022.[7]	Finland	Prospective study	5000 women without prior urinary incontinence (UI) who had a hysterectomy in a prospective FINHYST 2006 cohort study until the end of 2016 through a national health register.	Participants showed significant improvement in symptom severity across the study, which was most significant at 6 weeks postpartum (β= −4.245, p < 0.001). No significant difference was found in symptom severity between groups (β= −0.344, p = 0.168). The interaction effect between interven- tion and time on adherence was significant. Compared with the control group, greater self-efficacy was shown in the audio group at 6 weeks (β= 4.425, p = 0.009), 3 months (β= 3.204, p < 0.001) and 6 months (β= 4.457, p < 0.001) postpartum. Participants in the audio group indicated less bladder neck descent (16.5 vs. 19.5, p = 0.020) at 6 weeks postpartum, better pelvic floor muscle strength (12.5% vs. 34.0%, p = 0.012; 4.2% vs. 18.0%, p = 0.030) and sexual function (22.2 vs. 17.3, p = 0.007) at 6 months postpartum.
Marques, et al., 2020.[8]	Brazil	Prospective, assessor-blind, randomized clinical trial with parallel groups.	47 individuals with stress urinary incontinence	Regarding the daily frequency of urine loss evaluated by the follow-up voiding diary, an effect of group was observed (P< .001), with the PFH group showing a significant decrease in daily loss frequency, although no significant differences were found in the comparison between groups for the 3-day voiding diary, QoL, or functional assessment of the PFM.
Fakhrizal,et al., 2016.[9]	Indonesia	prospective observational cohort study.	Four hundreds primiparous women with no history of urinary incontinence.	The prevalence of postpartum SUI was 8.8%. The mode of delivery was significantly associated with postpartum SUI, there were more women who got vaginal delivery that had stress urinary incontinence (14.1%) compared to women caesarean section (7.1%) with OR=2.1 (95% CI=1.05-4.31), this risk increased when vaginal delivery was assisted with vacuum instrument (OR=9.1, 95% CI=3.9-21.6). There was no statistical difference of stress urinary incontinence incidences in patients with emergency or elective caesarean section with OR=0.84 (95% CI=0.28-2.57). Based on multivariate analysis BMI ≥30 kg/m2 at labor, vacuum assisted delivery, birth weight more than 3,360 g, and second stage labor more than 60 minutes appeared to be associated with an increased rate of postpartum SUI.
Qian, X., et al., 2024.[10]	China	retrospective case–control study con- ducted at a single center, involving data collection and analysis.	The data were derived from 164 patients who underwent laparoscopic total hyster- ectomy due to non-prolapse benign diseases	Only 97 individuals out of the initial 164 completed the ICIQ-FLUTS and PFDI-20 questionnaires. Among these participants, 28 patients (28.86%) were diagnosed with stress urinary incontinence (SUI) and constituted the study group, while 69 patients (71.13%) were categorized as women without SUI, comprising the control group. Factors such as age, menopause, parity of ≥2, Body Mass Index (BMI) of ≥28 kg/m², neonatal weight of ≥4000 g, history of chronic cough, preoperative hemoglobin of ≤100 g/L, preoperative urine bacteria of ≥100u/L, preoperative uterine volume of ≥90 cm³, intraoperative blood loss, and operation time were compared between the study and control groups. The observed differences were statistically significant (P < 0.05). Further logistic multivariate analysis identified menopause, preoperative hemoglobin of ≤100 g/L, preoperative urine bacteria of ≥100u/L, uterine volume of ≥90 cm³, history of chronic cough, and BMI of ≥28 kg/m² as risk factors for postoperative SUI.

Rubilotta, et al., 2019.[11]	Poland	Experimental study	544 women underwent urodynamic investigation.	Stress urinary incontinence was present in 323/544 (59.4%) patients. The prevalence of clinical P-SUI was 20.7% (67/323), while the prevalence of complicated SUI (C-SUI) was 79.3% (256/323). After UDI, diagnosis of P-SUI decreased to 18.3% (59/232). In 10.2% of cases (6/59) the scheduled middle urethral sling (MUS) was suppressed after the UDI results because 3/6 cases had detrusor overactivity and urge incontinence, in 2/6 cases SUI was treated with a conservative management, in 1/6 case an important voiding dysfunction was detected. Considering the national reimbursement in our country, the cost of each UDI was 296.5 euros and the total amount was 17,493.5 euros. So far the surgery-related savings covered 61.7–105.0% of the costs of total number of UDIs performed in the uncomplicated patients.

RESULT

Our search produced 21 results. After looking at the titles and summaries, we found 9 papers that fit our criteria. At first, we excluded several articles because they were written in review style. But after reading the full papers carefully, we included five papers in our final analysis. These papers included a retrospective observational study, prospective study, and randomized control trial.

A prospective national study, FINHYST 2006, involving 53 Finnish hospitals in 2006, investigated 5279 women who underwent hysterectomy for benign reasons. This study encompassed 79% of all benign hysterectomies performed in Finland that year. Written informed consent was obtained from all participants, who also granted permission for further analyses. Data were collected through surveys to gynecological surgeons and patients in 2006.[7]

Among the 5000 hysterectomies analyzed, vaginal hysterectomy (VH) was the most common, followed by laparoscopic hysterectomy (LH) and abdominal hysterectomy (AH). Subtotal procedures were infrequent, occurring in 6.5% of AH and 0.2% of LH cases. Fibroids were the predominant indication for hysterectomy, followed by pelvic organ prolapse (POP) in the VH group. Approximately 55% of hysterectomies involved concomitant surgery, with bilateral adnexal removal in 36% of AH and 32% of LH cases, and concomitant POP procedures in 54% of VH cases.[7]

Over a median follow-up of 10.6 years, 111 women (2.2%) underwent surgery for stress urinary incontinence (SUI). The rate of SUI operations was significantly higher after VH (3.3%) compared to AH (0.8%) and LH (1.8%). Midurethral sling procedures were predominant (97%), with the transobturator route slightly more frequently used than the retropubic route (53% vs. 44%). Operations were mainly performed due to SUI (87% of cases). Additionally, 4.8% of women had hospital visits for urinary incontinence, with 59% of these visits related to SUI.[7]

Univariate analysis revealed significant associations between SUI operations and UI visits with LH and VH compared to AH. Preceding POP and POP as the main indication showed equal associations with SUI operation and UI visit. In multivariate analysis, only vaginal hysterectomy was significantly associated with a higher risk of SUI operations. UI visits were significantly associated with preceding POP, three or more vaginal deliveries, and LH.[7]

In a sub-analysis excluding women with preceding POP, LH and VH remained significantly associated with both SUI operations and UI visits. Uterus size larger than 500 g was negatively associated with SUI operations and visits, while three or more vaginal deliveries were significantly associated with UI visits. The median time to SUI operations and UI visits did not differ significantly between hysterectomy approaches, but women with preceding POP had a significantly shorter median time to UI visits compared to those without preceding POP.[7]

This clinical trial followed a prospective, parallel, assessor-blinded, and randomized design, taking place in the outpatient physical therapy department of a university hospital. Initially, 311 patients complaining of urinary incontinence were selected from the urogynecology sections of two teaching hospitals. However, 264 individuals were excluded due to not meeting the inclusion criteria.[8]

Subsequently, 47 women with stress urinary incontinence (SUI) were randomly assigned to either the Pelvic Floor (PF) group or the Pelvic Floor with Home Exercises (PFH) group. Four participants did not complete the study due to personal issues, resulting in 21 participants in the PF group and 22 in the PFH group. In adherence to the study protocol, none of the patients changed their assigned group. However, the four patients who interrupted the protocol were not evaluated at the study's conclusion due to difficulties in contact. No side effects or harms to patients were reported during the study. [8]

Primary outcomes, specifically the daily frequency of urine leakage recorded in the follow-up voiding diary, revealed significant differences between the PF and PFH groups (group effect, $P < .001$). The PFH group exhibited a superior

outcome, with a significantly higher reduction in daily loss frequency compared to the PF group. However, no differences were found in terms of the effect of time (P = .819) or the interaction of group and time (P = .880), indicating that neither group improved faster than the other. The 3-day voiding diary showed no differences between the groups. [8]

Fakhrizal et al conducted observational cohort study with focus on primiparous women admitted to Arifin Achmad Hospital, Pekanbaru, Riau, between July 1st and December 31st, 2014. The criteria for inclusion were being a first-time mother with no history of urinary incontinence, single gestation, gestational age of 37 weeks or more, birth weight exceeding 2,500 grams, and willingness to participate by providing informed consent.[9]

A total of 447 eligible primiparous women were initially enrolled, and they completed a urinary incontinence questionnaire called the Questionnaire for Urinary Incontinence Diagnosis (QUID)19, which was translated, validated, and assisted by a trained research team. During the first examination after delivery, 31.6% of the population (137 subjects) experienced urinary incontinence, with 8.9% having stress urinary incontinence, 11.4% urge urinary incontinence, and 10.3% mixed urinary incontinence. [9]

At three months postpartum, 400 subjects (89.5%) returned for a second examination. Among them, 20.3% (81 subjects) still reported urinary incontinence, with 54.7% having persistent symptoms from the initial examination, and 7.41% being new cases. Stress urinary incontinence affected 8.8%, urge urinary incontinence affected 6.3%, and 5.3% had mixed urinary incontinence. Bivariate analysis of 354 primiparous women revealed that BMI classification ≥30, weight increase ≥15kg, episiotomy, perineal laceration stage 3-4, vacuum delivery, birth weight ≥3,360 g, and a second stage of labor ≥60 minutes were associated with persistent stress urinary incontinence at three months postpartum. [9]

In the multivariate analysis, factors significantly associated with persistent stress urinary incontinence were BMI >30 kg/m², vacuum delivery, birth weight >3,360 g, and a second stage of labor ≥60 minutes. Quality assessment using the Hosmer & Lemeshow test and an AUC value of 90.4% indicated good statistical quality for the multivariate analysis. [9]

Qian et al study, conducted at a single center, employed a retrospective case–control design, involving the collection and analysis of data. The primary aim was to explore the association between preoperative factors and the occurrence of stress urinary incontinence (SUI) following hysterectomy, rather than establishing a causal relationship. [10]

Univariate analysis focused on risk factors for SUI after laparoscopic hysterectomy. The study included 164 patients with benign non-prolapsed diseases who underwent the procedure. Completion of ICIQ-FLUTS and PFDI-20 questionnaires occurred in 97 patients, with an effective rate of 59.1%. The mean follow-up time was 55.0 ± 6.8 months. The study group comprised 28 patients (28.86%) with SUI, while the control group consisted of 69 women (71.13%) without SUI. SUI diagnoses were confirmed through Bonney and stress tests. Comparison of risk factors between the two groups revealed significant differences in various parameters, including age, SUI family history, menopause, parity ≥ 2, BMI ≥ 28 kg/m², neonatal weight ≥ 4000 g, history of chronic cough, preoperative hemoglobin ≤ 100 g/L, preoperative urine bacteria ≥ 100u/L, preoperative uterine volume ≥ 90cm³, intraoperative blood loss, and operation time ($P < 0.05$). A one-hour pad test in the study group indicated a mean urine leakage of 15.6 ± 2.3 g, with 60.7% of the patients having a significant degree of incontinence (more than 10 g). [10]

In multivariate analysis, variables with statistical significance in the univariate analysis underwent Logistic multivariate analysis. Age, preoperative hemoglobin ≤ 100 g/L, preoperative urine bacteria ≥ 100u/L, uterine volume ≥ 90cm³, history of chronic cough, and BMI ≥ 28 kg/m² emerged as risk factors for postoperative urinary incontinence in patients undergoing hysterectomy ($P < 0.05$). [10]

A single cohort comprising women who underwent Urodynamic Investigation (UDI) for urinary incontinence (UI) from January 2012 to July 2016 was prospectively collected and retrospectively analyzed. Data were extracted from an electronic database, and Urodynamic tests adhered to the Good Urodynamic Practice. [11]

Clinical Stress Urinary Incontinence (SUI) was diagnosed in 323 out of 544 (59.4%) patients. The prevalence of clinical Pure Stress Urinary Incontinence (P-SUI) was 20.7% (67 out of 323), while the prevalence of complicated SUI (C-SUI) was 79.3% (256 out of 323). After UDI, the diagnosis of P-SUI decreased to 18.3% (59 out of 323). In 11.9% (8 out of 67) of patients, the clinical P-SUI diagnosis was not confirmed due to the identification of predominant detrusor overactivity (3 cases), detrusor underactivity (4 cases), and voiding dysfunction (1 case). In 8.96% of cases (6 out of 67), the scheduled Midurethral Sling (MUS) procedure was canceled based on UDI results. Among these, detrusor overactivity and urge incontinence were detected in 3 out of 6 patients, pelvic floor rehabilitation successfully treated SUI in 2 out of 6 patients, and significant voiding dysfunction was identified in 1 out of 6 cases. The results are illustrated more comprehensively in Fig. 1, displaying patient characteristics based on clinical and UDI diagnoses and details about the cancellation of surgical UI correction after UDI. [11]

Considering the Italian National Health System reimbursement of 296.5 € for each UDI, the total cost for the 59 uncomplicated patients in our series was 17,493.5 €. If we take into account the reimbursement by our National Health System, which ranges from 1800–3073 € for each surgical procedure for female SUI (depending on the setting – Day

Surgery or hospitalization for two or more days), the total amount saved due to UDI findings ranged from 10,800–18,438 €. These savings cover 61.7–105.0% of the costs for the total number of UDIs performed in the uncomplicated patients in our series. [11]

DISCUSSION

In this prospective cohort study involving 5000 hysterectomies in women without prior urinary incontinence (UI), we explored the risk of stress urinary incontinence (SUI) operations following hysterectomy. The extended follow-up period of over 10 years aimed to capture all new UI cases, aligning with similar findings by Altman et al., where the risk peaked within 5 years post-hysterectomy. Despite only 2.2% undergoing SUI operations a decade later, the rate was double the expected national incidence in Finland in 2009. Interestingly, the rate of SUI operations was approximately half of the UI visit rate (2.2% vs. 4.8%), suggesting some women managed with conservative treatments.[7]

This study discovered that the risk of SUI operations was over twice as high after vaginal hysterectomy (VH) compared to abdominal hysterectomy (AH), even when adjusting for other factors and analyzing only women without preceding pelvic organ prolapse (POP). This finding aligns with a large cohort study in Sweden. However, as the choice of hysterectomy method wasn't randomized, favorable anatomy for VH, such as a mobile uterus or latent POP, could contribute to this disparity. Differences in re-establishing apical support between hysterectomy approaches might also explain added risks after laparoscopic hysterectomy (LH) compared to AH, given that uterosacral ligament fixation wasn't utilized in LH at the time of the sampled hysterectomies. Although re-establishing apical support is recommended to prevent post-hysterectomy POP, its impact on de novo UI after hysterectomy remains unclear.[7]

Preceding POP significantly increased the risk of UI visits but not SUI operations when adjusting for other factors, possibly indicating a higher prevalence of urge-dominant UI treated conservatively. Notably, women with a concomitant POP operation showed a similar rate of SUI operations and UI visits as those with preceding POP without a concomitant POP operation. This underscores the interconnected nature of SUI and POP as manifestations of pelvic floor dysfunction.[7]

Although the PFH group demonstrated positive outcomes in terms of the daily frequency of urine leakage recorded in the follow-up diary, no discernible differences were observed post-treatment between the conventional treatment and intervention groups concerning the 3-day voiding diary, pelvic floor muscle (PFM) strength and function, or the quality of life (QoL) in women with stress urinary incontinence (SUI). [8]

In this study, the sample was homogenous with respect to the type of UI, and an assessor blinded to the group allocation evaluated the participants. Initially, PFM strengthening involved bidigital assistance in both groups during the initial eight sessions to ensure correct PFM contraction independent of hip or trunk muscle contraction, effectively reducing urine leakage compared to printed workbook instructions. [8]

The study incorporated a follow-up voiding diary, in addition to the 3-day voiding diary, to gather more information on stress-related urine leakage. Based on the follow-up voiding diary, the group was the only factor showing statistical significance, suggesting that incorporating hip muscle exercises alongside pelvic floor strengthening may enhance PFM function. [8]

Results indicated that gains in PFM contraction strength and average pressure peak may not be the sole factors contributing to improved SUI symptoms. Although no differences were found in strength or perineometry between groups, the PFH group exhibited better results in urine loss throughout the evaluated sessions based on the follow-up voiding diary. This suggests that the reduction in SUI symptoms in the PFH group may be attributed to improvements in various aspects of pelvic floor functionality beyond muscular strength and peak contraction, such as muscle synergy, coordination, and motor control. [8]

Previous studies have highlighted the association of urinary incontinence not only with decreased pelvic floor muscle (PFM) activity but also with pelvic floor fatigue, emphasizing the need to evaluate these aspects clinically. The present study introduced hip muscle exercises, aiming to enhance muscular condition and synergic strategies in PFM contraction, considering the influence of muscle activation patterns on urinary continence. [8]

The anatomical relationships between the hip muscles and the PFM suggest a synergic action that may contribute to the effectiveness of physiotherapy treatment for SUI, as reflected in the follow-up voiding diary results. The study encourages further exploration of aspects beyond strength and perineometry, such as muscular coordination and functionality, to comprehensively understand the synergy between hip muscles and PFM in contributing to urinary continence mechanisms. [8]

In this investigation by Fakhrizal et al.,[9] 81 subjects (20.3%) experienced urinary incontinence at three months postpartum. This prevalence was higher than reported by Boyles[13] et al. in Oregon, USA (17.1%), but lower than the findings of a study in Scotland by Glazener et al.[12] (29%) and the meta-analysis by Thom and Rortveit (28.7%). Out of the 81 subjects with urinary incontinence, 35 (8.8%) had stress urinary incontinence (SUI), 25 (6.3%) had urge urinary incontinence/overactive bladder (UUI/OAB), and 21 (5.3%) had a mixed type.[9]

Regarding the distribution of urinary incontinence types, 43% of subjects had stress urinary incontinence, 31% had overactive bladder (OAB), and 26% had mixed urinary incontinence. These findings aligned with those of Glazener et al.22 and the meta-analysis by Thom and Rortveit.7,22 The study by Glazener et al.[13] reported 48% with SUI, 22% with OAB, and 30% with a mixed type, while Thom and Rortveit[14] found the frequency of SUI to be 46%, approximately twice the prevalence of OAB. Additionally, this study revealed an increased risk of SUI at three months postpartum in women with a BMI >30 kg/m2 (OR=4.74, 95% CI=2.29–9.79). However, an increase in maternal weight throughout gestation did not elevate the risk of postpartum SUI (OR=1.67, 95% CI=0.82–3.39). Vaginal delivery in primiparity was associated with a higher risk of persistent SUI than cesarean section (OR=2.1, 95% CI=1.05–4.31). The risk increased further if the vaginal delivery was assisted by a vacuum device (OR=9.1, 95% CI=3.9–21.6), consistent with the findings by Glazener et al.[12] and the meta-analysis by Thom and Rortveit.[14]

Notably, emergency cesarean section did not increase the risk of SUI compared to elective cesarean section (OR=0.84, 95% CI=0.28–2.57), in line with Boyles et al.12 This suggests that the protective effect of cesarean section against the risk of SUI is consistent regardless of the timing of the cesarean section. Birth weight greater than 3,360 g and especially exceeding 3,700 g significantly increased the risk of SUI, echoing the findings of Eftekhar et al.25 and Glazener et al. [12] The study also highlighted an escalating risk of SUI in subjects with a longer duration of the second stage of labor, specifically exceeding 60 minutes. The increased risk was substantial (52.4%) compared to durations less than 60 minutes (7.2%), supporting the findings of Boyles et al. [13]

Stress urinary incontinence (SUI) is characterized by the involuntary release of urine during activities such as sneezing, coughing, or physical exertion. Regarded as one of the five major health-affecting conditions, urinary incontinence not only constrains women's daily lives and activities but also profoundly impacts their overall quality of life. Additionally, it can lead to psychological challenges such as depression and loneliness, imposing a substantial burden on patients and giving rise to a cascade of social and health-related issues, thereby placing a significant financial strain on healthcare systems.[8]

The prevalence of SUI varies depending on the study population. According to European and American statistics, the incidence of SUI in women aged 40 and older is approximately 15.9%. Chinese data indicate an overall SUI incidence of about 18.9% in adult women, increasing to 28.0% in those aged 50–59. The China Development Report 2020 predicts that nearly 100 million elderly women will be affected by SUI by 2050. [8]

The incidence of female SUI is influenced by diverse factors, including age, race, pregnancy, childbirth, and pelvic organ surgery. Research by Brown et al.[15] demonstrated an increased long-term risk of urinary incontinence, reaching 60% for women around the age of 60, following hysterectomy. Another study by Kudish et al. revealed a significant rise in SUI and urge urinary incontinence three years post-hysterectomy.[16] Urodynamic measurements confirmed a correlation between hysterectomy and the severity of SUI, with patients who underwent hysterectomy exhibiting a significantly lower mean Valsalva leak point pressure (VLPP) compared to the general population. Our study found a 5-year SUI incidence of 28.86% post-hysterectomy, significantly higher than the overall incidence in adult women. This suggests that hysterectomy may impact the lower urinary tract system, contributing to an increased SUI incidence. The underlying pathogenesis is believed to be associated with the disruption of pelvic floor support structures during hysterectomy, particularly the injury to pelvic ligaments and changes in anatomical positions.[10]

Risk factors for postoperative SUI were analyzed in a case–control study on patients undergoing laparoscopic subtotal hysterectomy in 2017. Univariate and multivariate logistic regression analysis identified age, preoperative hemoglobin ≤ 100 g/L, preoperative urine bacteria ≥ 100u/L, uterine volume ≥ 90cm3, a history of chronic cough, and BMI ≥ 28 kg/m2 as significant risk factors for postoperative SUI. Beyond the well-established risk factors, this study considered factors influencing patient recovery before, during, and after hysterectomy, including preoperative nutritional status, occult urinary tract infection, and surgical factors. Findings indicated that, in addition to age and obesity, poor preoperative nutritional status, a large uterus, and occult urinary system infection are major risk factors for postoperative SUI.[10]

This study also shed light on key factors contributing to the development and severity of SUI. Age emerged as a significant risk factor, aligning with previous research indicating an age-related increase in SUI prevalence. Obesity also played a crucial role, with excess body weight and increased abdominal pressure posing strain on pelvic floor muscles. Chronic cough, notably in patients with chronic obstructive pulmonary disease (COPD), was identified as a risk factor, highlighting the impact of repeated increases in intra-abdominal pressure during coughing episodes. Elevated preoperative urine bacteria levels (≥ 100u/L) and a uterine volume ≥ 90cm3 were associated with an increased risk of postoperative UI, emphasizing the importance of addressing urinary tract infections and considering surgical techniques that minimize trauma to the pelvic floor. Low hemoglobin levels (≤ 100 g/L) emerged as a potential risk factor for postoperative SUI, with hypotheses suggesting impaired tissue healing and potential associations with underlying health conditions. While the exact mechanisms warrant further investigation, clinicians should be attentive to preoperative anemia in the comprehensive assessment and management of patients undergoing hysterectomy. [10]

The literature offers limited data on Preoperative Stress Urinary Incontinence (P-SUI), with reported prevalence ranging from 5.2% to 36% [1, 2, 12, 13]. In this series, the prevalence stood at approximately 20%, in line with the findings presented by Jeong.[17] Some researchers positive that the elevated prevalence of P-SUI may be attributable to restricted clinical skills. Consequently, our comparatively lower rate could be linked to a higher level of expertise in the realms of urodynamics and female urology. Additionally, this expertise might account for the notable concordance between Urodynamic Investigation (UDI) findings and clinical data—a matter of significant debate in the literature.

Following UDI, some patients underwent alterations in their therapeutic approach, resulting in a noteworthy reduction of unnecessary surgical procedures (8.96%). Conversely, numerous women might have received inappropriate surgical treatment, specifically Mid-Urethral Sling (MUS), had they not undergone UDI before surgery. Our results align with those of Serati et al., who reported modifications or cancellations of planned SUI surgeries in 9.7% and 9.5% of cases, respectively.[18]

In 2010, the USA witnessed the implantation of 260,000 MUS procedures. Considering a prevalence of clinical P-SUI at 20.7% (as per our study), it is estimated that around 52,000 women underwent MUS for P-SUI surgical correction.[19] Among these patients, almost 4,659 (8.96%) might have undergone unnecessary surgery if UDI had not been administered before the surgical intervention.

Consequently, the issue of unnecessary surgical procedures emerges as a significant clinical and economic concern. Re-intervention rates associated with voiding dysfunction or mesh extrusion have been reported in 3.7% of cases.[20] While acknowledging the limitations of this analysis, when we juxtapose such data with our results, an estimated 172 women may have experienced these complications due to unnecessary surgical treatment. Moreover, factoring in the reported chronic pain rate of 4.1% after MUS, the projected number of patients with this potential complication after an unnecessary surgery would be around 191. According to literature data, 740 mesh removal procedures have been reported in peer-reviewed publications, and 7,654 meshes were removed in patients presenting with sling complications,[18]cited study, applying our criteria confirms the previously reported results: 1,738 patients were presumed to have P-SUI, and in 156 cases, the SUI surgical intervention could have been canceled after UDI.

In light of these considerations, we assert that UDI may assist in the clinical diagnostic process for all women with SUI, not just those with complications. UDI has the potential to eliminate unnecessary surgical treatments and their potential consequences. A comprehensive cost analysis should take into account both direct and indirect costs. Direct costs encompass the total expenses for a single UDI, the surgical procedure, and hospitalization. Negative externalities comprise costs incurred in complicated patients, including repeated UDI, the use of devices, and potentially new surgical treatments and hospitalization. Our estimated rate of unnecessary surgical treatment at 8.96% implies that, without UDI, these women would have had their insurance/health care cover the cost of their surgery without a confirmed indication. Nonetheless, insurance/health care would have also covered the costs associated with managing negative externalities.[11]

CONCLUSION

In this comprehensive ten-year systematic review on stress urinary incontinence (SUI), key findings include a 2.2% prevalence of SUI operations post-hysterectomy, a persistent association between vaginal hysterectomy (VH) and SUI operations, and significant links between preceding pelvic organ prolapse (POP), vaginal deliveries, laparoscopic hysterectomy (LH), and urinary incontinence (UI) visits. The study also reveals that combining pelvic floor muscle (PFM) strengthening with hip synergic muscle exercises improves daily urine loss frequency. Vaginal delivery is identified as a higher risk factor for SUI compared to cesarean delivery, with modifiable factors such as achieving an ideal body weight and preventing traumatic vaginal delivery showing promise as preventive measures.

A cost analysis of preoperative stress urinary incontinence (P-SUI) demonstrates that savings from avoiding unnecessary surgical treatments through urodynamic investigations (UDIs) in uncomplicated patients cover associated expenses. The study emphasizes the need to consider potential legal actions in a comprehensive cost assessment of negative externalities. In summary, this systematic review provides nuanced insights into the prevalence, associations, preventive measures, and cost implications of stress urinary incontinence, offering a comprehensive understanding of its multifaceted implications over a decade.

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