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REVIEW

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Risk factors of stress urinary incontinence in pelvic organ prolapse patients: a systematic review and meta-analysis

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Abstract

Background Stress urinary incontinence (SUI) and pelvic organ prolapse (POP) commonly coexist as global problems that affect the quality of life of millions of women. The study aimed to identify the risk factors of stress urinary incontinence in pelvic organ prolapse patients.

Main body A systematic review and meta-analysis was conducted in Web of Science, PubMed, and Scopus based on the PRISMA flowchart. The quality of the study was assessed using Newcastle–Ottawa Scale and data were collected on a modified table from The Cochrane Library. Meta-analysis was conducted using RevMan 5.4. Seven hundred forty studies were found that matched the keywords. After the screening, 16 studies met the inclusion and exclusion criteria with a total of 47.615 participants with pelvic organ prolapse. A total of 27 risk factors were found in this review. History of hysterectomy (OR = 2.01; 95% CI 1.22–3.33; $p = 0.007$), obesity (OR = 1.15; 95% CI 1.02–1.29; $p = 0.02$), and diabetes mellitus (OR = 1.85; 95% CI 1.06–3.23; $p = 0.03$) were shown to be risk factor of stress urinary incontinence in pelvic organ prolapse patients.

Conclusions History of hysterectomy, obesity, and diabetes mellitus were found to be the risk factors of stress urinary incontinence in pelvic organ prolapse patients.

Keywords Stress urinary incontinence, Pelvic organ prolapse, Risk factors

1 Background

Stress urinary incontinence (SUI) and pelvic organ prolapse (POP) commonly coexist as worldwide problems that affect the quality of life of millions of women [1]. The International Continence Society (ICS) has defined stress urinary incontinence as a condition in which the complaint of any involuntary loss of urine on physical movement or activity (for instance coughing, sneezing, laughing, standing up or running, heavy lifting) or in conditions that elevate the abdominal pressure (stress) on the bladder [2]. The prevalence of SUI worldwide may vary in different studies. In the USA, the 2005–2016 prevalence of SUI is 26%. The incidence of SUI is highest among women aged 40–59 years [3]. In Asia, a study conducted in China estimated the prevalence of SUI is 12.4%.

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SUI incidence peaked at 60–69 years [4]. In Australia, up to 50% of Australian women were affected by SUI [5]. The estimated pooled prevalence of SUI in Sub-Saharan Africa was 52% [6]. Prevalence of SUI in Europe ranges between 21.4% in Denmark and 24.4% in Germany. SUI was most likely to occur in younger women [7].

POP is the descent or herniation of the pelvic organs (bladder, rectum, uterus) into the vaginal introitus due to weakness of the vaginal wall [8]. POP is divided into 4 types based on the descent of the pelvic organ, cystocele (anterior wall prolapse), rectocele (posterior wall prolapse), uterine prolapse, and vaginal vault prolapse [9]. POP were estimated to occur in half of all parous women, but less than 30% were symptomatic [8, 10, 11]. In 2050, the incidence of POP in the USA is predicted to increase 46–200% according to the population growth [10]. Vaginal vault prolapse occurs in 6–12% of women after hysterectomy [9, 10], while in two-thirds of cases develops multi-compartment prolapse [10]. Symptomatic POPs are increased by 3% associated with the increase of each unit of Body Mass Index (BMI) [11].

The relationship between stress urinary incontinence and POP is based on the normal anatomy and physiology of the pelvic floor [12]. The weakening of pelvic diaphragm muscles, when exposed to intra-abdominal pressure, would lead to POP. During stress or increased intra-abdominal pressure, urine leakage occurs due to internal sphincter deficiency [13]. Among women with POP, 37–54% of them reported concurrent SUI [14]. Considering the pathophysiologic process, the development of these disorders is likely to be influenced or triggered by several similar factors. Several factors such as age, parity, obesity, history of hysterectomy, and menopause are known to increase the risk of POP and SUI [12, 15]. However, the correlation between these factors and the occurrences of SUI in POP patients remain unclear. Further research is needed for better understanding. We conducted a systematic review and meta-analysis to identify the risk factors of stress urinary incontinence in pelvic organ prolapse.

2 Main text

2.1 Materials and methods

2.1.1 Eligibility criteria

This review only included studies with a population of women diagnosed with any type of POP without age restriction. Observational studies such as case–control and cohort studies were also included in this review. Included studies should have one or more risk factors, written in bahasa Indonesia or English, and the full text of the studies are available. POP patients with pregnancy and urinary tract infections were excluded. Randomized controlled trials (RCT) and secondary analysis were also excluded. We exclude the RCT study because we did not use any intervention or treatment in the patients. While secondary analysis cannot be included because in this review required an original article to be included.

2.1.2 Information sources

Information was obtained from studies that were published in Web of Science, PubMed, Scopus databases. Each database was last searched until June 2022. Hand searching was also performed through citations of studies that are similar to this review.

2.1.3 Search strategy

A systematic search was conducted on Web of Science, PubMed, and Scopus databases until June 2022. The keywords used were Pelvic Organ Prolapse; Stress Urinary Incontinence; Risk Factors, according to the MeSH Term of each keyword. Then these keywords are entered in the advanced search field of the database by adding the boolean operator 'AND' between each keyword to get specific results. Meanwhile, to get the results of synonyms according to the MeSH Term, the boolean operator 'OR' is used. The boolean asterisk operator (*) is also used to find words with different endings. Therefore, the keywords used in the search became ("Pelvic Organ Prolapse" OR "Urogenital Prolapse") AND ("Stress Urinary Incontinence" OR "Urinary Stress Incontinence") AND "Risk Factor*". The protocol of this review was registered in PROSPERO, with the identification number being CRD42022364828.

2.1.4 Selection process

The selection process is based on the Preferred Reporting Items guidelines for systematic reviews and meta-analyses (PRISMA) flowchart. Before the screening, we used automation tools to remove studies that are not available in English and are not a research article. Then, we removed the duplicate studies. The screening process was done by reviewing the title and abstract of the studies, and this process was conducted by two independent reviewers (ANF and EMK). Eligible potential studies were assessed by reading the full text of studies. In case of disagreement between the two reviewers, the third reviewer (SIW) resolved the conflict.

2.1.5 Data collection process and data items

Data extraction was performed by all authors (ANF, EMK, WIS) using modified data collection form for intervention reviews. Important information that was extracted is author name, year of publication, title, country, study design, number of patients, incidence SUI in POP patients, diagnostic tools, duration of follow-up, age, parity, history of hysterectomy, menopausal status, body mass index (BMI), risk factors studied, odds ratio (OR), confidence interval (CI), and *p*-value. If the OR was not reported, it was calculated. Risk factors were defined as statistically significant if the *p*-value score is < 0.05.

2.1.6 Study risk of bias assessment

The risk of bias was assessed using the Newcastle–Ottawa Quality Assessment Scale (NOS) for cohort and case–control studies. Each study was assessed on eight items, categorized into three groups: selection, comparability, and exposure or outcome of interest for case–control or cohort studies, respectively. Each item that is considered good quality is marked with a star. The quality of a study is judged by the number of stars it gets. The maximum number of stars that can be obtained is nine stars. The more stars it gets, the higher the quality of the study. Studies that get 7–9 stars have high quality, 4–6 stars have a high risk of bias, while studies with 0–3 stars have a very high risk of bias.

2.1.7 Synthesis methods

Studies included in the systematic review are then grouped into SUI and No SUI to be assessed quantitatively. There are 4 risk factors such as age, history of hysterectomy, diabetes mellitus, and obesity that were analyzed for meta-analysis. The meta-analysis was conducted using RevMan 5.4 and performed generic inverse variance using odds ratio (OR) and confidence interval (CI) from the included studies to present the forest plot. As the heterogeneity was high, we used a random-effect model for the analysis. We intended to assess publication bias using funnel plot techniques, Begg's rank test, and Egger's regression test, as appropriate given the known limitations of these methods.

2.2 Results

2.2.1 Study selection

A total of 740 studies were obtained from 3 databases, 274 studies on the Web of Science, 205 studies on PubMed, and 261 studies on Scopus. One hundred seventy were marked as ineligible using automation tools and 105 duplicate studies were also excluded. A total of 465 studies proceeded to the screening process. About 425 studies did not meet the inclusion criteria, then 40 studies were assessed for eligibility. There were 2 studies in which the full-text was not accessible, 14 studies with different outcomes in the same population were excluded. Eight studies were excluded because the population was different but the outcomes remained the same, while 2 studies were excluded because the study design was a secondary analysis. Two studies that matched the inclusion and exclusion criteria were obtained through a hand-searching method. The total studies included in the systematic review are 16 studies, 9 studies were assessed in meta-analysis. The study selection process of this review is presented in the PRISMA flowchart on Fig. 1.

2.2.2 Risk of bias in studies

The quality of studies was comprehensively assessed using Newcastle–Ottawa Quality Assessment Scale (NOS) for cohort and case–control studies. This review obtained 1 case–control study and 15 cohort studies. Only one study that was considered to have a high risk of bias, because it only achieved 6 stars. The other 15 studies collected 7–9 stars, therefore they were considered as high quality studies. The risks of bias are summarized in Table 1.

2.2.3 Study characteristics and results of individual studies

From the included studies, there are seven studies from the Asian continent [17, 20, 22, 24, 26, 28, 31], six studies from the European continent [16, 18, 25, 27, 29, 30], two studies from the USA [19, 23], and one study conducted in Brazil [21]. Thirteen studies carried out data collection retrospectively while the other three studies were collected prospectively. The total participants involved in this review were 47,615 patients with pelvic organ prolapse and 3100 of them experienced stress urinary incontinence. The diagnostic tools used to identify stress urinary incontinence were urodynamic examination, stress test or cough test, and questionnaire. The fastest follow-up duration was 6 weeks [20], while the longest was 4 years later [23]. The longest follow-up duration ranged from 1 month to 1 year [31]. More details of study characteristics in this review can be seen in Table 2.

Characteristics of the sample obtained include age, parity, history of hysterectomy, menopausal status, and BMI. The average patient with pelvic organ prolapse is over 60 years old with a parity of 2–3 times. The history of hysterectomy in patients varies between 10–81.1% while more than 60% of patients with pelvic organ prolapse have experienced menopause. The average BMI of the patients ranged from 23.5–27.4 kg/m2. In this systematic review, 27 risk factors for stress urinary incontinence were found in patients with pelvic organ prolapse. A total of 5 studies stated that obesity is a risk factor for stress urinary incontinence in patients with pelvic organ prolapse [16, 21, 23, 27, 31], 4 studies on age risk factors [20, 23, 28, 31], 2 studies on hysterectomy history [22, 26], and 1 study each on parity number [29] and menopausal status [20]. Other significant risk factors were preoperative stress urinary incontinence in 5 studies [18, 24, 25, 27, 30] and history of diabetes mellitus in 3 studies [21, 23, 28]. Table 3 below describes the sample characteristics and research results from the included studies. From

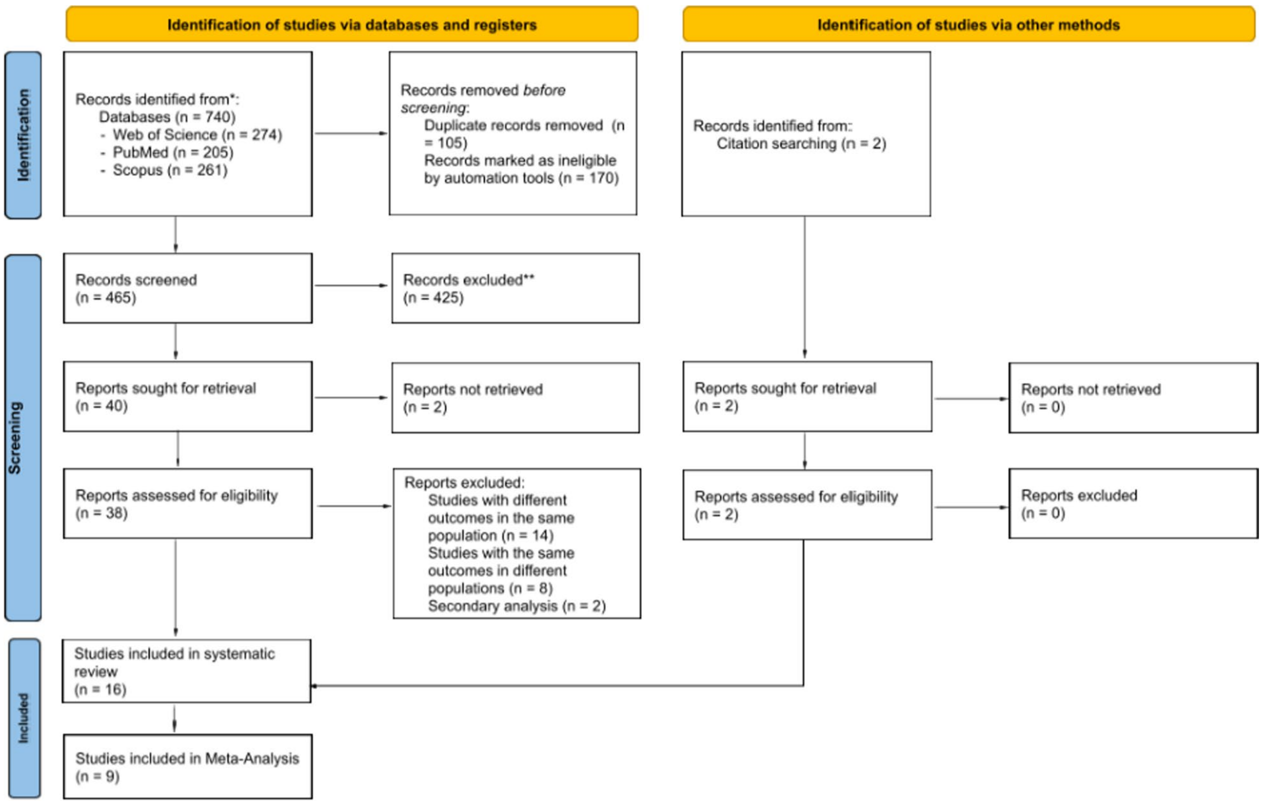

Fig. 1 PRISMA flowchart

Table 1 Risk of bias assessment using the Newcastle–Ottawa Scale (NOS)

No	References	Study design	Selection	Comparability	Exposure	Total
1	Wang et al. [17]	Case–control	4★	2★	3★	9★
2	Leruth et al. [18]	Cohort	3★	2★	3★	8★
3	Le Claire et al. [19]	Cohort	3★	2★	2★	7★
4	Reena et al. [20]	Cohort	4★	2★	2★	8★
5	Cruz et al. [21]	Cohort	4★	2★	3★	9★
6	Syan et al. [23]	Cohort	3★	1★	2★	6★
7	Sato et al. [24]	Cohort	3★	2★	3★	8★
8	Song [26]	Cohort	3★	2★	3★	8★
9	Lensen et al. [27]	Cohort	4★	2★	3★	9★
10	Khayyami et al. [16]	Cohort	3★	2★	2★	7★
11	Kawaguchi et al. [22]	Cohort	3★	2★	2★	7★
12	Bideau et al. [25]	Cohort	3★	2★	3★	8★
13	Lo et al. [28]	Cohort	4★	2★	2★	8★
14	Ugianskiene et al. [29]	Cohort	4★	2★	2★	8★
15	Frigerio et al. [30]	Cohort	4★	2★	2★	8★
16	Hu et al. [31]	Cohort	2★	2★	3★	7★

16 studies included in systematic review, only 9 studies were marked as eligible because it can be pooled quantitatively and assessed in meta-analysis. Parity and menopausal status were excluded because there was only one study included in each risk factor. While preoperative stress urinary incontinence (SUI) was excluded because it was only applied for pelvic organ prolapse (POP) patient that undergo the surgery. The

Table 2 Characteristics of Included Studies

No	References	Study Characteristics					
		Country	Study design	Number of patients	Incidence SUI in POP patients	Diagnostic test	Duration of follow-up
1	Khayyami et al. [16]	Denmark	Retrospective data-base study	1198	45%	ICIQ-UI-sf	3 months
2	Wang et al. [17]	China	Nested Case–control Study	300	75 (25%)	OABSS and ICIQ questionnaires; 1-h pad test and/or uro-dynamic examina-tion	3–24 months
3	Leruth et al. [18]	Belgium	Retrospective cohort study	55	30 (54.5%)	a cough test (with and without manual prolapse reduction), urinalysis, cystos-copy, and multichan-nel UDS with pro-lapse reduction	25 ± 11 (range 12–48) months
4	Le Claire et al. [19]	USA	Retrospective cohort	77	22 (28.6%)	Cough stress test and Valsalva maneu-vers	ASCP: 15 weeks (range 7– 99); MISCP: 12 weeks (range 2–90)
5	Reena et al. [20]	India	Prospective cohort study	78	67.90%	Perineal pad	6 weeks
6	Cruz et al. [21]	Brazil	Retrospective cohort study	146	3 months foll-up: 23 (15.8%); 12 months foll-up: 30 (20.5%)	Stress test; Urody-namics	3 and 12 months
7	Kawaguchi et al. [22]	Japan	Retrospective study	961	258/448 (57.6%)	noninstrumented uroflowmetry and questionnaires OABSS, IPSS/QOL score, and ICIQ-SF	12 months
8	Syan et al. [23]	USA	Large Population-based Cohort	41,689	1504 (3.6%)	underwent a SUI surgical procedure	4.1 ± 1.7 years
9	Sato et al. [24]	Japan	Retrospective cohort study	83	27 (32.53%)	ICIQ-SF	13 months (range 12–24 months)
10	Bideau et al. [25]	France	Retrospective single-center study	308	29%	a cough stress test or by urodynamic testing	12 months
11	Song et al. [26]	China	Prospective cohort study	206	45 (21.8%)	standardized POP-Q measurements, stress test, 1-h pad test, and uroflow-metry	31 months (range 12–48 months)
12	Lensen et al. [27]	The Netherlands	Prospective cohort study	907	22%	The Urogenital Distress Inventory (UDI)	12 months
13	Lo et al. [28]	Taiwan	Retrospective	637	71 (11%)	cough stress test, urinary analysis, and cultures; multi-channel UDS	6 months–1 year
14	Ugianskiene et al. [29]	Denmark	Retrospective study	299	19 (6%)	ICIQ-VS and ICIQ-UI SF	3 months
15	Frigerio et al. [30]	Italy	Single-center retro-spective study	417	87	ICIQ-SF Question-naire	6 months
16	Hu et al. [31]	China	Retrospective cohort study	254	51	Clinical examination; USG	1 month–1 year

ICIQ International consultation on incontinence questionnaire; *UI* urinary incontinence; *SF* short form; *VS* vaginal symptoms; *OABSS* overactive bladder symptom score; *IPSS* international prostate symptom score; *QOL* quality of life; *UDS* urodynamic studies

Table 3 Sample characteristics

No	References	Sample characteristics					Outcome Data	Effect Measure	
		Age (years)	Parity (*n*)	Hysterectomy (yes)	Menopause (yes)	Obesity (BMI kg/m2)	Risk Factors Studied	OR (95% CI)	*p*-value
1	Khayyami et al. [16]	62.5 (±11.4)	2 (range 0–8)	–	–	24.8 (17.5–47.0)	BMI	1.07 (1.03–1.11)	0.001
2	Wang et al. [17]	64.3 ± 11.0	2.4 ± 1.2	46 (61.3%)	59 (78.7%)	24.7 ± 3.6	LUTO	2.3 (1.2–4.6)	0.013
3	Leruth et al. [18]	63.6 ± 8.3 (range 49–79)	2.7 ± 1.7 (range 0–9)	9 (16.4%)	–	25.4 ± 3.3 (range 20.0–32.1)	Preoperative SUI	RR 4.032 (1.159–14.085)	0.028
4	Le Claire et al. [19]	62 (±7.4)	2.5	ASCP: 11 (33.3%); MISCP: 16 (36.4%)	–	ASCP: 27.42 (±4.19); MISCP: 27.15 (±4.48)	Greater reduction in point Aa	4.67 (1.14, 19.22)	0.012
							Abdominal surgical route	4.37 (1.42, 13.48)	0.005
5	Reena et al. [20]	51.24 years (range, 27– 75)	3.3 (range, 1–9)	–	47 (60.3%)	–	Age ≥ 50	2.07 (0.41–10.41)	< 0.005
							Postmenopausal	2.60 (0.54–12.50)	< 0.003
6	Cruz et al. [21]	61.2 (±7.0)	–	27 (18.5%)	–	27.4 (±3.8)	High BMI	RR 1.19 (1.05–1.36)	< 0.01
							Diabetes	RR 4.18 (1.32–13.21)	0.01
							POP-Q Stage ≥ 3	RR 14.74 (1.64–132.0)	0.01
7	Kawaguchi et al. [22]	68 (range 43–89)	2 (range 0–9)	150 (15.6%)	939 (97.7%)	23.5 (range 16.4–35.1)	History of hysterectomy	1.802 (1.010–3.217)	0.046
							cQmax (> 1.5)	2.147 (1.325–3.480)	0.002
							Preoperative UUI	1.525 (1.027–2.269)	0.036
8	Syan et al. [23]	59	–	–	–	n = 940 (2.3%)	Age	1.01 (1.00–1.02)	< 0.01
							Obesity	1.98 (1.51–2.57)	< 0.01
							DM	1.19 (1.01–1.41)	0.03
							combined anterior and apical repair	1.3 (1.14–1.48)	< 0.01
							use of mesh for POP repair	2.04 (1.79–2.32)	< 0.01
9	Sato et al. [24]	71 (range 66–75)	2 (range 2–3)	–	–	23.6 (range 22.0–25.1)	Preoperative SUI	3.95 (1.14–13.7)	0.03
							increased Ba measurements	1.44 (1.00–2.06)	0.04
10	Bideau et al. [25]	69 ± 7.4 years	2 ± 1.45	32 (10%)	286 (93%)	25 ± 4	Preoperative SUI	2.68 (1.35–5.31)	0.005
11	Song et al. [26]	59.5 ± 12.3 years	2 (range 0–9)	29 (14.1%)	158 (76.7%)	24.3 ± 2.9	Concomitant hysterectomy	2.86 (1.02–7.99)	0.044
							OSUI	4.19 (1.99–8.86)	0.000

Table 3 (continued)

No	References	Sample characteristics					Outcome Data	Effect Measure	
		Age (years)	Parity (*n*)	Hysterectomy (yes)	Menopause (yes)	Obesity (BMI kg/m2)	Risk Factors Studied	OR (95% CI)	*p*-value
12	Lensen et al. [27]	62 (range 29–100)	2 (range 0–7)	–	718 (79%)	26 (range 16–42)	High BMI	1.045 (1.003–1.088)	< 0.05
							COPD	3.519 (1.573–7.869)	< 0.05
							Preoperative SUI	6.455 (4.650–8.960	< 0.05
13	Lo et al. [28]	28–46 (7%); 47–65 (29.6%); > 66 (63.4%)	0–2 (15.5%); 3–5 (76%); > 6 (8.5%)	50 (70.42%)	64 (90.1%)	17–23 (23.9%); 23.1–29 (64.8%); > 29.1 (11.3%)	Age ≧66	2.86 (1.01–2.53)	0.014
							DM	2.18 (1.63–4.21)	0.002
							MUCP < 60 mmH2O	4.65 (2.87–8.64)	< 0.001
							FUL < 2 cm	3.48 (2.13–5.83)	< 0.001
							TVM type Prolift T	3.5 (1.88–5.91)	< 0.001
							TVM type Elevate A	3.48 (1.90–6.10)	< 0.001
14	Ugianskiene et al. [29]	57 (range 28–68)	3 (range 1–5)	7 (21.2%)	–	27.1 (range 21.9–37)	Parity	–	0.03
15	Frigerio et al. [30]	63.4 ± 11.2	2.0 ± 1.0	87 (100%)	80 (92%)	24.8 ± 3.4	Preoperative SUI	3.11	0.001
							Pdet at maximum flow < 30 cm H2O	2.93	0.019
16	Hu et al. [31]	69.3 (± 7.0)	2	–	50 (98%)	28.1 (± 2.8)	Unilateral levator avulsion	RR 2.23 (1.35–3.68)	< 0.05
							Bilateral levator avulsion	RR 3.12 (1.46–6.67)	< 0.05
							Age	–	< 0.05
							Obese	–	< 0.05

eligible studies were grouped into SUI as an experimental group and No SUI as a control group. This meta-analysis was conducted in RevMan 5.4. Four risk factors were assessed using the generic inverse variance method to obtain pooled odds ratio from included studies, can be seen in Fig. 2 (a–d).

The result of this meta-analysis indicated that obesity, history of hysterectomy, and diabetes mellitus were significant risk factors for the development of stress urinary incontinence in pelvic organ prolapse patients. The *p*-value of each risk factor reaches below 0.05 except for age with a *p*-value of 0.29. Other significant risk factors can be seen in obesity (OR = 1.15; 95% CI 1.02–1.29; $p = 002$), history of hysterectomy (OR = 2.01; 95% CI 1.22–3.33; $p = 0.007$), and diabetes mellitus (OR = 1.85; 95% CI 1.06–3.23; $p = 0.03$).

2.2.4 Risk of bias across studies

Publication bias was not assessed as there were inadequate numbers of included studies to properly assess a funnel plot or more advanced regression-based assessments.

2.3 Discussion

This review showed that obesity, history of hysterectomy, and diabetes mellitus could increase the incidence of stress urinary incontinence in pelvic organ prolapse patients. Obesity is defined as abnormal or excessive fat accumulation that presents a risk to health [32]. This review considered body mass index (BMI) ≥ 25 kg/m^2 as obesity. Khayyami et al. [16] stated that the risk of stress urinary incontinence in patients with a BMI < 25 kg/m^2 was 12% and 16% with a BMI of 25 to < 30 kg/m^2. Meanwhile, in patients with a

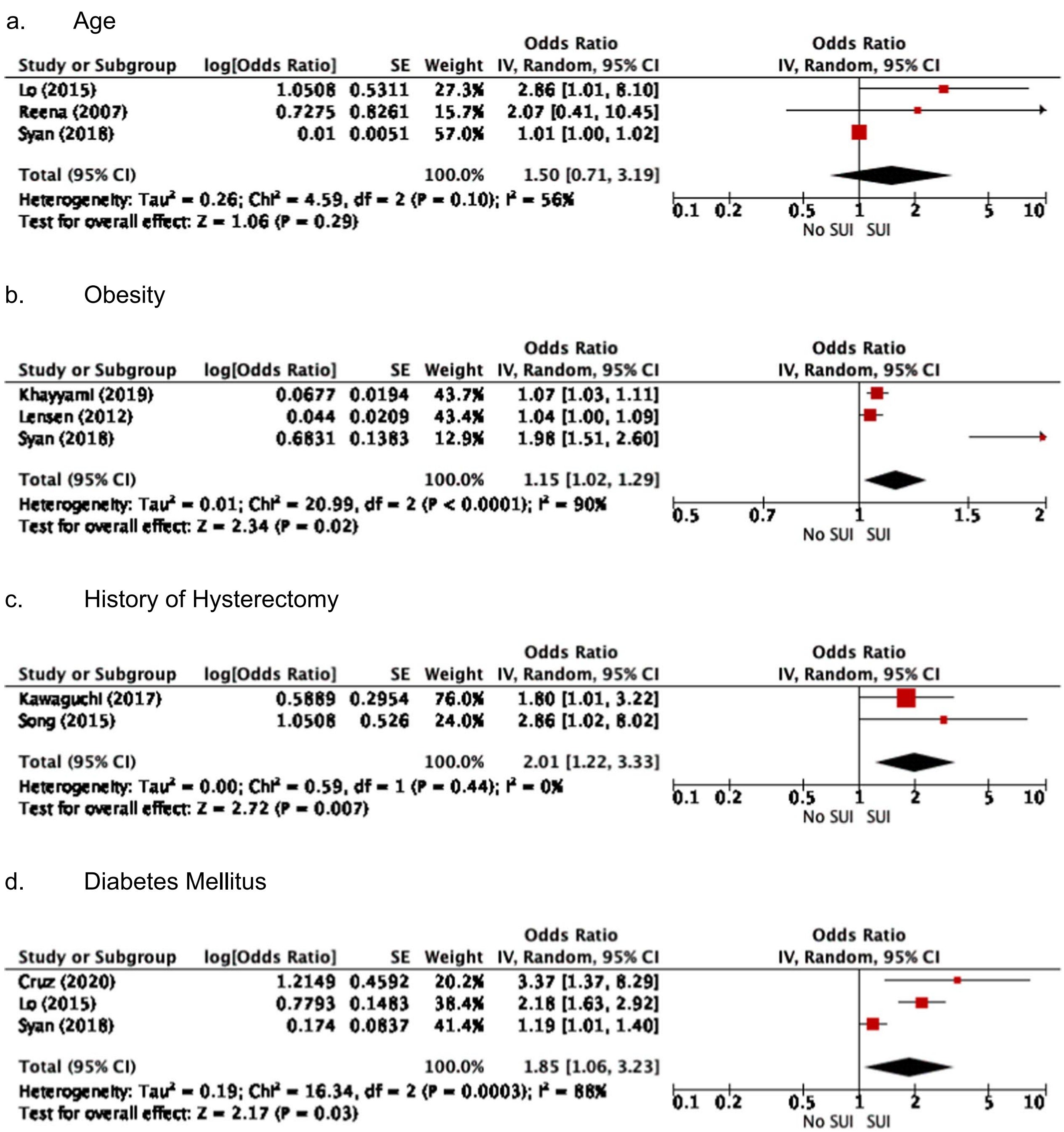

Fig. 2 Forest plot in this meta-analysis

BMI > 30, the risk increases by 23% or 2 times more than in patients with a BMI < 25 [16]. In a study conducted by Rodríguez-Miaz et al. [12] found that the incidence of obesity in patients with pelvic organ prolapse and stress urinary incontinence was 28.2% with a mean BMI of 28 kg/m^2 [12]. Guin et al. [33] showed a higher incidence of stress urinary incontinence in patients with BMI of 25–29.99 kg/m^2 was 78.57% [33].

The relationship between obesity and the incidence of stress urinary incontinence can be explained by an increase in intra-abdominal pressure due to obesity. Increased intra-abdominal pressure causes weakness of pelvic musculature and nerve supply. This results in increased intravesical pressure and urethral mobility so that stress urinary incontinence can occur [34]. A 5-point increase in BMI can increase the risk of urinary incontinence by 20–70%. Stress urinary incontinence can improve with weight loss with lifestyle modification and bariatric surgery [35]. Loss of more than 5% of BMI could lower the risk of experiencing new or persistence SUI over 3 years [38]. Similarly, the incidence of SUI could reduce by 3% for each kilogram of weight loss in one year [39].

Hysterectomy is a surgical procedure to treat benign conditions such as pelvic organ prolapse [36]. According to a study conducted by Heydari et al. [37], it was found that stress urinary incontinence occurred 6.3 times more in patients with a history of hysterectomy compared to those who had never had a hysterectomy. Patients with a history of hysterectomy are likely to experience severe stress urinary incontinence [37]. The incidence of post-hysterectomy stress urinary incontinence is increased in the 3rd year after hysterectomy [38]. From the two included studies [22, 26] in this review, pooled odds ratio reach 2.01 fold. Stress urinary incontinence after hysterectomy may occur due to prolonged injury of the pelvic plexus when performed uterosacral/cardinal ligament complex transection. Leading to the formation of a bladder flap and impaired anatomic support of the bladder neck and urethra [38].

Diabetes mellitus is a chronic metabolic disease characterized by elevated levels of blood glucose [39]. Based on the three included studies [21, 23, 28], the increase in the incidence of stress urinary incontinence varied by 1.19–3.37 fold in patients with pelvic organ prolapse with a history of diabetes mellitus. Diabetes can be associated with urinary incontinence through glucosuria and microvascular damage, similar to the process seen in retinopathy and peripheral neuropathy. Microvascular damage causes weakened connective tissue support and dysfunction of the pudendal nerve endings resulting in weakness of the urethral sphincter. The occurrence of glucosuria in diabetic patients causes an increase in the amount of urine volume so that it can reduce bladder contractility. An increase of 1% of the HbA1c value can increase the risk of stress-type urinary incontinence by 34% [40].

A cross-sectional multicenter study of 178 women with SUI found that the severity of SUI was related to age, perineometer results, and education level [41]. Another study found that independent risk factors for new-onset postoperative POP were age ≥ 50 years, gravidity ≥ 3 times, parity ≥ 3 times, history of macrosomia delivery, history of chronic respiratory disease, vaginal delivery, and perineal lacerations. Pelvic floor muscle training by biofeedback electrical stimulation is a protective factor. POP patients with new-onset SUI after mesh implantation should perform pelvic floor muscle training [42].

Age in this review suggested greater than 50 years old. Thus, older age is not significantly related to a higher incidence of SUI in POP patients. This was in line with a predictive model provided by Jelovsek et al., revealed that increasing age would decrease risk of experiencing SUI after POP surgery [32]. The older study also revealed that the prevalence of SUI peaked at the age of 40–49 years old and then subsequently decreased [33].

There are several limitations to this meta-analysis. Main limitation of this review is that this meta-analysis only included a limited number of eligible studies, so that the publication bias assessment cannot be done. The types of research also vary so that there is a risk of bias. Those risk factors were excluded because the number of studies does not meet the minimum requirement to be assessed in meta-analysis. The regression analysis cannot be done due to an inadequate number of included studies. We already perform the correlation analysis using a forest plot. Most of the studies included in this review only reported the risk of SUI after POP surgery. While our review is more focused on the development of SUI in the POP population in general. Another limitation is the lack of access to the raw data of the studies included. Therefore, the odds ratio could not be calculated for some risk factors. Some risk factors identified in this review were also not specific to SUI. Despite the limitations, we believe this is the first study to assess several risk factors simultaneously using meta-analysis to provide a better understanding of and predict the risk of developing SUI in POP patients. To summarize, we found several risk factors for SUI, such as obesity, hysterectomy, and diabetes mellitus that could be easily identified using history-taking in the POP patient. We hope this is applicable by clinicians to raise awareness and early detection of SUI in POP patients. Future researchers need to do original research that addresses this topic so that the meta-analysis that is carried out further can be better.

3 Conclusion

This systematic review and meta-analysis found 27 risk factors of stress urinary incontinence in pelvic organ prolapse patients. Three risk factors are marked as quantitatively significant: obesity, history of hysterectomy, and diabetes mellitus.

Abbreviations

SUI	Stress urinary incontinence
POP	Pelvic organ prolapse
ICS	The International Continence Society
NOS	Newcastle–Ottawa quality assessment scale
BMI	Body mass index

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Author contributions

All authors have contributed to all processes in this research, including preparation, data gathering and analysis, drafting and approval for publication of this manuscript. ANF: Conception or design of the work, Data collection, Drafting the article. EMK: Data collection, Data analysis and interpretation, Drafting the article. SIW: Drafting the article, Critical revision of the article. CDK: Drafting the article, Final approval of the version to be published.

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Declarations

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Availability of data and materials

Data supporting this study are included within the article and/or supporting materials.

Competing interests

The authors declare that there is no conflict of interest.

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