Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

Analysis of selected factors in pelvic organ prolapse and urinary incontinence and the differentiation of clinical forms – a pilot study

Jakub Mroczyk
Poznan University of Medical Sciences https://orcid.org/0009-0000-8272-7534
Grażyna Jarząbek-Bielecka
Poznan University of Medical Sciences
Piotr Merks
Cardinal Stefan Wyszyński University in Warsaw
Katarzyna Plagens-Rotman
Poznan University of Medical Sciences
Witold Kędzia
Poznan University of Medical Sciences
Magdalena Pisarska-Krawczyk
Uniwersytet Kaliski
Barbara Więckowska
Poznan University of Medical Sciences
Justyna Kaczor
Poznan University of Medical Sciences
Małgorzata Mizgier
Poznań University of Physical Education
Agata Puszcz
agata.puszcz@yahoo.com

Poznan University of Medical Sciences: Uniwersytet Medyczny imienia Karola Marcinkowskiego w Poznaniu https://orcid.org/0009-0009-3695-3245

Research Article

Keywords: pelvic organ prolapse, stress urinary incontinence, factors

Posted Date: July 27th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-10463105/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

Additional Declarations: The authors declare no competing interests.

Analysis of selected factors in pelvic organ prolapse and urinary incontinence and the differentiation of clinical forms – a pilot study

Abstract

Pelvic organ prolapse (POP) and stress urinary incontinence (SUI) are common pelvic floor disorders, affecting nearly half of adult women. Although various factors contribute to these conditions, they often coexist, complicating diagnosis and treatment. The aim of the study was to identify modifiable risk factors could improve prevention strategies and treatment planning. This retrospective pilot study was carried out among 398 women who underwent surgical treatment for either POP (n=225) or SUI (n=173) at the Gynecology Clinic of Heliodor Święcicki Clinical Hospital in Poznań. Participants were assigned to groups based on clinical and imaging examination results. The following variables were analysed: age, body mass index (BMI), obstetric history (term births, preterm births, and miscarriages) and smoking status. A statistical analysis was performed using the Mann-Whitney U test ($p<0.05$). The study found no statistically significant correlations between miscarriages or preterm births and the occurrence of POP or SUI. However, multiparity was identified as a risk factor for both conditions, particularly following term births. While a high BMI was prevalent in both groups, there was a non-significant trend indicating that SUI was more frequent among overweight or obese women. Increased smoking rates were observed in both groups, though the differences were not statistically significant. Multiparity and high BMI are significant risk factors for POP and SUI. In contrast, miscarriages, preterm births and smoking did not show significant relationships. Future studies should include larger populations and consider additional influencing factors.

Keywords

pelvic organ prolapse, stress urinary incontinence, factors

1. Introduction

Pelvic floor disorders, such as pelvic organ prolapse (POP) and stress urinary incontinence (SUI) are among the most common health issues affecting reproductive and post-menopausal women. These conditions significantly diminish quality of life and impact social functioning, professional activities, and mental health. Although POP and SUI can coexist, they require different diagnostic and treatment approaches. In clinical practice, it is essential to identify the primary dysfunction. Key factors considered in this analysis include the number of births, the delivery method (whether preterm or at term), body mass index (BMI), and smoking status. These risk factors were examined collectively and individually in relation to both conditions to determine whether they are present and to assess if any differences are statistically significant.

2. The Aim

To check whether the analyzed risk factors for pelvic organ prolapse differentiate clinical problems in POP and SUI. The study aimed to develop protective strategies focused on modifiable factors and to enhance understanding of the underlying mechanisms of both disorders.

3. Materials and methods

This retrospective study analysed the medical records of 398 female patients diagnosed with pelvic organ prolapse (POP) and stress urinary incontinence (SUI), classified according to ICD-10. All patients underwent surgical treatment at the Gynaecology Clinic of the Clinical and Obstetrics Hospital at Karol Marcinkowski Medical University in Poznań. The analysis was conducted among a group of women at a single facility, using ICD-10 diagnoses and a standardised diagnostic algorithm.

The study groups were formed based on hospital referrals from gynaecologists, which included preliminary diagnoses and the extent of planned surgical treatment. Upon hospital admission, the women were independently evaluated by the head of the department or authorised specialists with relevant qualifications.

The diagnostic process included a gynaecological examination, a speculum examination, an assessment of pelvic organ support, and the identification of stress urinary incontinence symptoms using the Valsalva manoeuvre and cough stress test. Special attention was given to the nutritional status of mucous membranes, their oestrogenisation, and any signs of inflammation. All women underwent a transvaginal ultrasound examination to evaluate the anatomy of the urinary bladder, the uterus, and the length and shape of the urethra. In cases of anterior compartment prolapse and suspicion of occult stress urinary incontinence (occult SUI), further examination of the urethra and urinary bladder was conducted to assess the anatomical repositioning of the vaginal wall.

Other potential causes of urinary incontinence, such as urge incontinence, mixed urinary incontinence with a dominant urge component, neurogenic bladder, and detrusor overactivity, were ruled out in all patients with these symptoms. In cases where the diagnosis was unclear, patients were referred to a urologist with a recommendation to maintain a micturition diary and to undergo further diagnostic examinations, including urodynamic tests.

Based on the type of pelvic floor dysfunction, two subgroups were identified:

Group 1: Prolapse (n = 225)

This group consisted of patients with uterine and/or vaginal wall prolapse, primarily affecting the medial and posterior pelvic compartments, and who did not exhibit significant symptoms of urinary incontinence. In cases of anterior pelvic prolapse, only patients without occult SUI were included. Based on our clinical experience, we do not perform simultaneous surgical repair of POP and SUI. Patients with occult SUI were considered for POP surgery first and, if necessary, underwent further treatment for SUI afterward.

The surgical procedures performed included anterior and posterior colporrhaphy, colpocleisis, the Manchester operation, and transvaginal hysterectomy.

ICD-10 codes:
N81.0 – Urethrocele
N81.1 – Cystocele (including cystocele with urethrocele)
N81.2 – Incomplete uterovaginal prolapse (grade I–II)
N81.3 – Complete uterovaginal prolapse (grade III)
N81.4 – Uterovaginal prolapse, unspecified
N81.5 – Enterocele
N81.6 – Rectocele
N81.8 – Other female genital prolapse (e.g. deficient perineum, old laceration of muscles)
N81.9 – Female genital prolapse, unspecified
Diagnoses N81.0 and N81.1 were only considered if there was no evidence of occult SUI.

Group 2: Urinary incontinence (n = 173)

This group consisted of women diagnosed stress urinary incontinence and patients with anterior vaginal wall and urethral prolapses who were experiencing symptoms of occult urinary system dysfunction. The patients with SUI were considered for transobturator tape (TOT) or tension-free vaginal tape (TVT) surgery, while those with occult SUI were eligible for corrective procedures.

ICD-10 codes:
N39.3 – Stress urinary incontinence
N81.0 – Urethrocele
N81.1 – Cystocele

Diagnoses N81.0 and N81.1 were included only if occult SUI was present. For further analysis, these groups were categorised as “Prolapse” and “Urinary incontinence”.

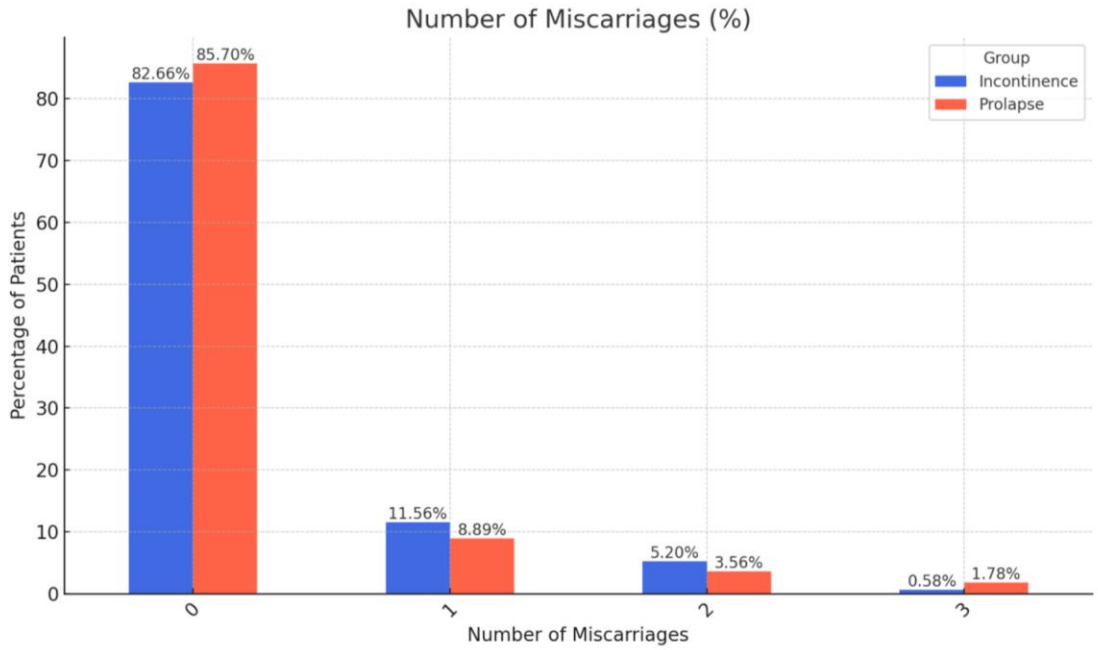
Statistical analysis

Statistical analyses were conducted using PQStat v1.8.6 (Poznań, Poland). A p-value of less than 0.05 was considered statistically significant. A Mann-Whitney U test was applied for continuous variables (as a normal distribution could not be assumed, this was confirmed by a Shapiro-Wilk test). For binary variables, a chi-square test (χ^2) was employed, and for ordinal variables, a chi-square test for trends was used. Additionally, for binary outcomes, the

odds ratio (OR) was calculated, along with 95% confidence intervals, to assess the strength of associations between the variables.

4. Results

Chart 1



The majority of women did not have a history of miscarriages: 143 (82.66%) patients from the urinary incontinence group and 193 (85.70%) from the prolapse group. In contrast, 30 women (17.34%) in the urinary incontinence group and 32 women (14.22%) in the prolapse group reported experiencing miscarriages. The odds ratio for miscarriages was calculated at 0.79, with a 95% confidence interval of 0.56–1.36, and a p-value of 0.395.

Table 1. History of miscarriages among the respondents

		Incontinence N=173	Prolapse N=225	Total N=398	OR (95 CI)	p value
Miscarriage	yes	30 (17.34%)	32 (14.22%)	62 (15.58%)	0.79 (0.56-1.36)	0.395
	no	143 (82.66%)	193 (85.78%)	336 (84.42%)		

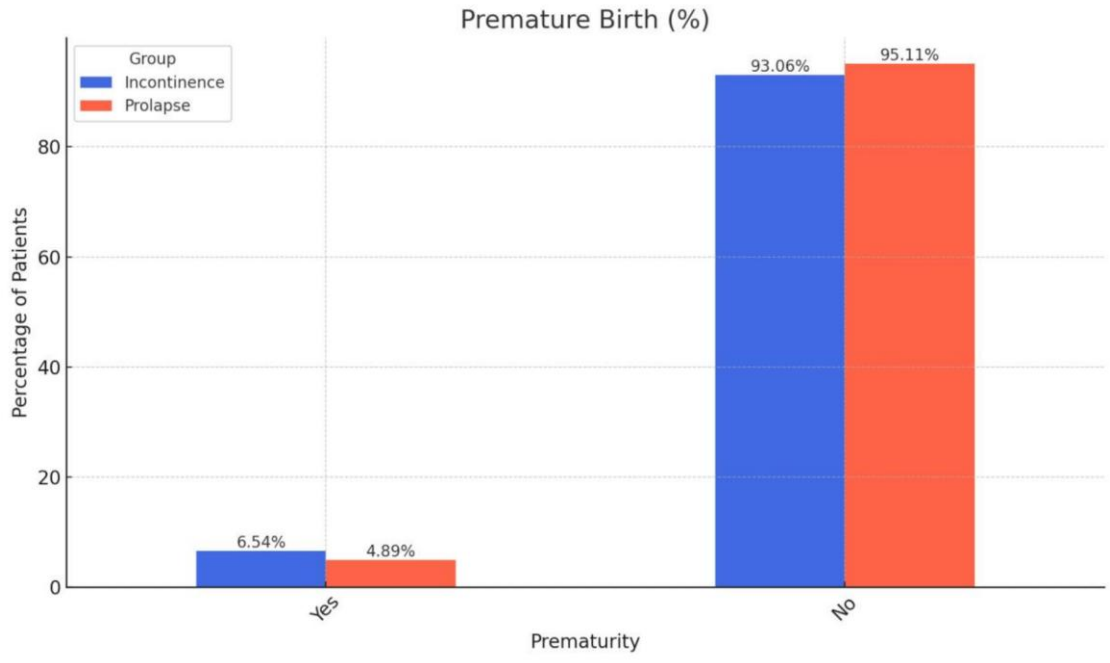
Table 2. Number of miscarriage among the respondents

		Incontinence N=173	Prolaps N=225	Total N=398	OR (95 ci)	Value p	Statistic test
Number of miscarriage						0,6857	Chi-square test for trends
	3	1(0,58%)	4(1,78%)	5(1,26%)	2,96 (0,33;26,8)		
	2	9(5,2%)	8(3,56%)	17(4,27%)	0,66 (0,25;1,75)		
	1	20(11,56%)	20(8,89%)	40(10,05%)	0,74 (0,38;1,43)		
	0	143(82,66%)	193(85,7%)	336(84,42%)	reference		

In terms of the number of miscarriages reported, 20 women (11.56%) with urinary incontinence compared to 20 women (8.89%) with organ prolapse indicated experiencing one miscarriage (OR: 0.74; 95% CI: 0.38–1.43). Additionally, 9 women (5.20%) with urinary incontinence reported two miscarriages, while 8 women (3.56%) with organ prolapse did the same (OR: 0.66; 95% CI: 0.25–1.75). Furthermore, 1 woman (0.58%) with urinary incontinence reported having three miscarriages, compared to 4 women (1.78%) with organ prolapse (OR: 2.96; 95% CI: 0.33–26.8).

Although the data indicates that one and two miscarriages occurred more frequently among women with urinary incontinence, and three miscarriages were more common in the prolapse group, these differences were not statistically significant (p= 0.6857).

Chart 2

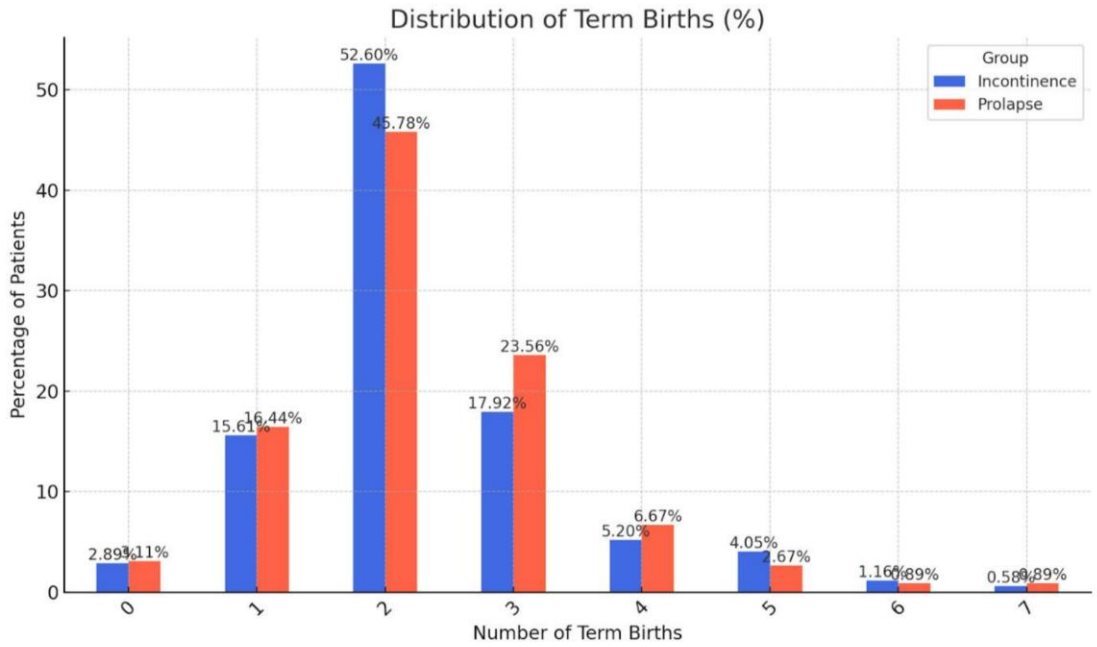


In the study, 12 women (6.54%) in the urinary incontinence group and 11 women (4.89%) in the prolapse group reported having preterm births. None of the participants had more than one preterm birth.

Table 3. History preterm births among the respondents

		Incontinence N=173	Prolapse N=225	Total N=398	OR (95 CI)	p value
Preterm births	1	12 (6.54%)	11 (4.89%)	23 (5.78%)	0.69 (0.30-1.60)	0.3855
	0	161 (93.06%)	214 (95.11%)	375 (94.22%)		

Chart 3



The majority of births were at term; 93.06% of patients in the urinary incontinence group and 95.11% of women in the prolapse group. Among the participants, nulliparous women represented 2.89% in the urinary incontinence group and 3.11% in the prolapse group.

Table 4. Term births

		Incontinence N=173	Prolaps N=225	Total N=398	OR (95 ci)	Value p	Statistic test
Birth at term						0,5556	Mann- Whitney
	Mean+-SD	2,27+-1,14	2,3+-1,14	2,29+-1,14			
	Mediane (Q1;Q3)	2(2;3)	2(2;3)	2(2;3)			
	7	1(0,58%)	2(0,89%	3(0,75%)			
	6	2 (1,16%)	2(0,89%)	4(1,01%)			
	5	7(4,05%)	6(2,67%	13(3,27%)			
	4	9(5,2%)	15(6,67%)	24(6,03%)			
	3	31(17,92%)	53(23,56%)	84(21,11%)			
	2	91(52,6%)	103(45,78%)	194(48,74%)			
	1	27(15,61%)	37(16,44%)	64(16,08%)			
	0	5(2,89%)	7(3,11%)	12(3,02%)			

Distribution based on the number of births

- 1 birth: 27 women (15.61%) in the urinary incontinence group vs. 37 women (16.44%) in the prolapse group (OR: 0.96)
- 2 births: 91 women in the urinary incontinence group (52.60%) vs. 103 women (45.78%) in the prolapse group (OR: 0.81)
- 3 or more births: 50 women in the urinary incontinence group (28.90%) vs. 78 women (34.67%) in the prolapse group (OR: 1.11)

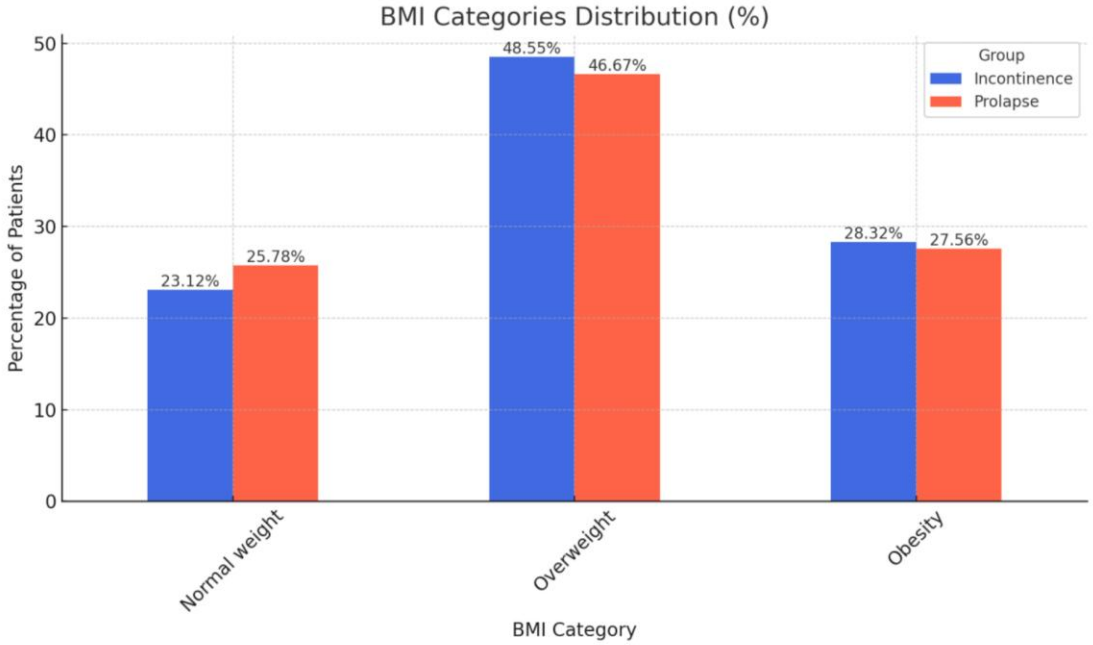
While the prolapse group had a higher frequency of multiple births (three or more), the differences observed were statistically insignificant.

Overall, the results indicate that the majority of participants experienced at least two births at term, suggesting that multiparity may be a risk factor. The differences between POP and SUI were not statistically significant (**p = 0.5646**).

Table 5. Birth at term (0,1,2,3 and more)

		Incontinence N=173	Prolaps N=225	Total N=398	OR (95 ci)	Value p	Statistic test
Birth at term (0,1,2,3 and more						0,5646	Chi-square test for trends
	3 and more	50(28,9%)	78(34,67%)	128(32,16%)	1,11 (0,34,3,70)		
	2	91(52,6%)	103(45,78%)	194(48,74%)	0,81 (0,25,2,64)		
	1	27(15,81%)	37(16,44%)	64(15,08%)	0,96 (0,28, 3,42)		
	0	5(2,89%)	7(3,11%)	12(3,02%)	reference		

Chart 4



Despite a slight tendency for a higher BMI in the urinary incontinence group, the differences between the two groups were statistically insignificant (p = 0.6399).

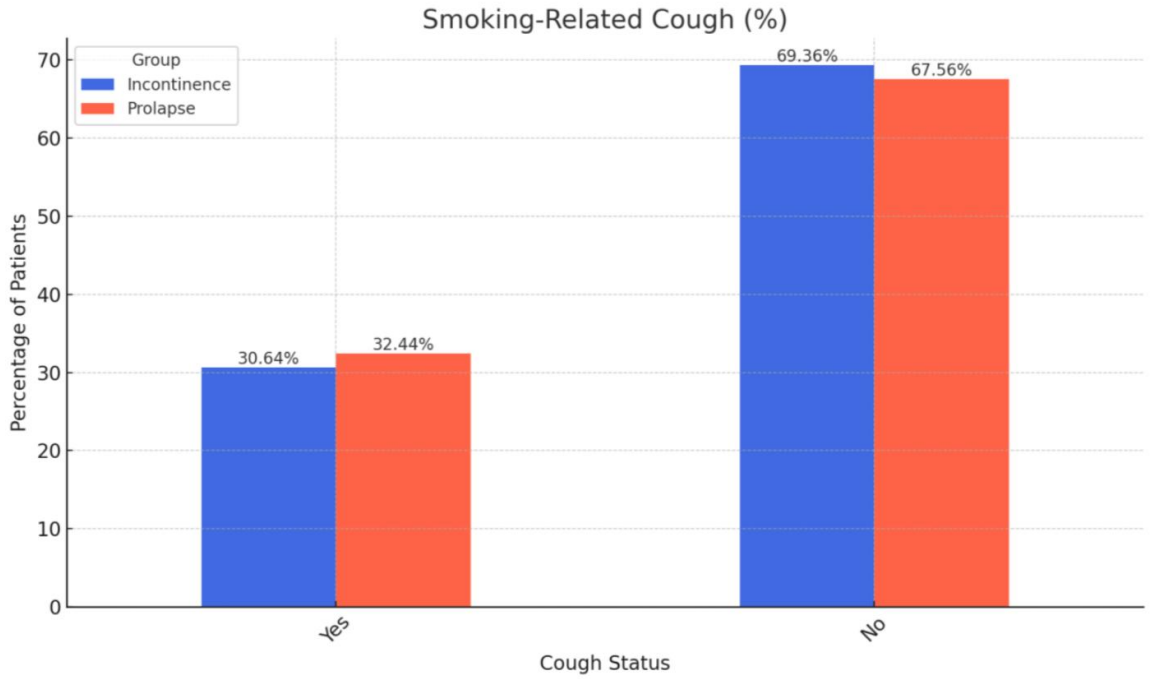
The results indicate that a higher BMI is common in both conditions, but it does not distinguish between them. Nonetheless, this tendency underscores the need for further studies on BMI as a potential risk factor, especially for SUI.

Table 6-7. Body Mass Index (BMI)

		Incontinence N=173	Prolapse N=225	Total N=398	p value
BMI	Mean+-SD	28.02 +-4.48	27.75+ 4.54	27.87+4.51	0.6303
	Median (Q1;Q3)	27.34 (25.26;30.47)	27.55 (24.98;30.12)	27.51 (25.04;30.45)	

		Incontinence N=173	Prolapse N=225	Total N=398	OR (95 ci)	Value p	Statistical test
BMI categories						0.6399	Chi-square test
	Normal weight	40 (23.12%)	58(25.78%)	98(24.62%)	reference		
	Overweight	84(48.55%)	105(46.67%)	189(47.49%)	0.86 (0.53; 1.41)		
	Obesity	49(28.32%)	62(27.56%)	111(27.89%)	0.87 (0.50;1.1)		

Chart 5.



The majority of patients in both groups were non-smokers and did not report a smoking-related cough:

- 120 women (69.36%) in the urinary incontinence group
- 152 women (67.56%) in the prolapse group

Smoking-related cough was reported by:

- 53 women (30.64%) in the urinary incontinence group
- 73 women (32.44%) in the prolapse group

OR = 1.09; 95% CI: 0.71–1.67; p = 0.7006 – no statistical significance.

Although a slightly higher frequency of smoking and cough was observed in the prolapse group, the differences were not statistically significant. The percentage of smokers in both groups was somewhat higher than the national average for women in Poland. While smoking and a chronic cough may significantly increase the mechanical burden of pelvic floor structures, this study suggests that smoking cannot be considered an independent factor differentiating between POP and SUI.

Table 8.

		Incontinence N=173	Prolaps N=225	Total N=398	OR (95 ci)	Value p	Statistic test
Smoking and smoking related cough						0,7006	Chi-square test
	yes	53(30,64%)	73(32,44%)	126(31,66%)	1,09(0,71;1,67)		
	no	120(69,36%	152(67,56%)	272(68,34%)	reference		

Discussion

Stress urinary incontinence (SUI) and pelvic organ prolapse (POP) are distinct pelvic floor disorders that often coexist and require different diagnostic and therapeutic approaches. Patients with advanced POP frequently experience SUI, particularly after corrective procedures, due to changes in the pelvic floor anatomy. Additionally, the symptoms of SUI can be masked by advanced organ prolapse and may become apparent following anatomical restoration. This study aimed to accurately differentiate between these two patient groups.

However, categorising patients simply into “urinary incontinence” and “cystocele” groups may oversimplify the complex nature of pelvic floor disorders. Clinically, organ prolapse typically involves multiple pelvic compartments, reflecting a more intricate pathophysiology than single-compartment models suggest [1, 2].

The study groups were created retrospectively based on the medical records of patients who qualified for surgical treatment. This classification was made according to clinical symptoms and the results of the examinations mentioned above. The objective was to optimise the surgical treatment plan to achieve the best possible therapeutic outcomes, in accordance with current evidence-based guidelines [3, 4]. Contemporary literature and clinical recommendations emphasise the importance of precise anatomical correction to reduce the risk of recurrence and to preserve pelvic organ function [5, 6].

The allocation of patients to groups was based on ICD-10 codes defined by referral physicians and confirmed by specialists at the clinic during the pre-operative evaluation.

The study did not employ advanced imaging techniques, such as magnetic resonance imaging (MRI) or dynamic 3D ultrasound. While some authors [7] have highlighted the diagnostic value of these methods, our study did not aim to evaluate them. The use of high-resolution MRI may significantly enhance anatomical assessments by identifying dominant

components of pelvic floor dysfunctions. This could be particularly important for achieving a more accurate diagnostic classification and standardisation of analyses in the future [8, 9].

Miscarriages

Existing literature on the relationship between miscarriages and POP or SUI is limited and inconsistent. In our study group, 80% of the women had never experienced a miscarriage. Among those with a history of miscarriage, 17.34% were in the urinary incontinence group, while 14.22% were in the prolapse group. These figures align with population data indicating that 10-20% of women experience at least one miscarriage in their lifetime [11]. Therefore, we can consider our sample representative in this regard.

An inverse relationship was observed between the number of miscarriages and the size of the subgroups; specifically, the more miscarriages a woman had, the fewer cases were recorded. This pattern aligns with epidemiological reasoning and may suggest no significant relationship between the number of miscarriages and an increased risk for POP or SUI. In cases of one or two miscarriages, SUI was more frequent. However, in the group of patients with three miscarriages, this trend reversed. The small number of cases (a total of five) prevents us from drawing firm conclusions. Although the odds ratio of 2.96 suggests a potential relationship, the broad confidence interval (0.33–26.8) complicates the interpretation.

The dependency between the number of miscarriages and SUI was found to be statistically insignificant. This indicates that the number of miscarriages, regardless of frequency, cannot be considered an independent risk factor for developing stress urinary incontinence. Existing literature partially supports this observation. A systematic review by Siahkal et al. identified the main risk factors for SUI in women as the number and course of births, body mass, age, and perinatal injuries, while miscarriages were not deemed significant [14]. Similar conclusions were reached by Kılıç and Abdullah et al. in their population studies [15, 16]. Conversely, Zhang et al. (2021) determined that the primary predictors of SUI were factors associated with increased intra-abdominal pressure, such as physical exertion, obesity, and chronic coughing, while a history of miscarriages was not significantly linked to SUI symptoms [10].

In the context of POP, neither Puri nor Paudel et al. identified miscarriages as a significant risk factor. They instead highlighted the importance of multiple births, delivery length, and other perinatal factors [12][13]. Kapoor et al. proposed that reproductive complications, including miscarriages, might lead to cervical injuries and connective tissue remodelling, which could predispose individuals to POP [17]. Although this hypothesis seems biologically plausible, our data did not confirm it.

Fatima et al. also showed a weak and statistically insignificant correlation between the number of miscarriages and POP [18]. In analysing cases of POP diagnosed during pregnancy, Shqara et al. noted a comorbidity with past miscarriages. However, due to the small sample size, it was not possible to draw reliable statistical conclusions [19].

Preterm births

In this study, the percentage of preterm births among women with POP and SUI was found to be low and comparable to reference values for the general female population in Poland. Specifically, 6.94% of patients in the urinary incontinence group reported preterm births, while in the prolapse group the percentage was 4.89%. Overall, 5.78% of all participants experienced preterm births, which is lower than the national average of approximately 6.7%

[20]. The lack of significant differences between the groups (OR = 0.69; 95% CI: 0.30–1.60) indicates that gestational age at the time of delivery is not an independent risk factor for either POP or SUI. These findings align with existing literature. For instance, a cohort study by Repo et al. identified that the main predictors of urinary incontinence following delivery were biomechanical factors, such as a prolonged second stage of delivery, high birth weight, and natural childbirth, rather than gestational age [21]. Additionally, Witkoś and Hartman-Petrycka (2020) emphasised that the primary risk factor for SUI is mechanical pelvic floor injuries that occur during delivery, rather than gestational age. They also pointed out the lack of awareness about the true risk factors for SUI among future healthcare professionals [22]. A systematic review by Dai et al. also did not find a significant correlation between preterm birth and SUI. The main risk factors identified included the method by which delivery concluded, pelvic floor muscle dysfunction, and the absence of early postnatal rehabilitation [23].

Although Yang and Zhang et al. speculated about potential common molecular pathways for preterm births and pelvic floor disorders, such as the overexpression of matrix metalloproteinases and collagen degradation, these theories have yet to be widely confirmed in population studies [24, 25].

The study conducted by Toloza et al. on pelvic floor muscle training demonstrated that preventive interventions, regardless of gestational age, have a more significant impact on reducing the risk for SUI than perinatal factors do [26].

Given this data, the lack of correlation between preterm births and an increased risk of urinary incontinence, as shown in this study, is both logical and consistent with the current understanding. The key risk factors for SUI include the method and progression of delivery, as well as mechanical factors that affect the integrity of the structures supporting the urethra, rather than the timing of delivery itself.

Term births

Multiple cohort studies, meta-analyses and systematic reviews have confirmed that multiparity, particularly in the context of natural childbirth, is a key risk factor for pelvic organ prolapse (POP) and stress urinary incontinence (SUI) [27, 28]. Special attention is given to a woman’s first vaginal delivery, as it can cause permanent damage to the muscles and fasciae that support pelvic organs and regulate urinary control [28, 29].

In this study, women who had never given birth accounted for 2.9% of the urinary incontinence group and 3.11% of the prolapse group, which aligns with previous reports suggesting that POP and SUI are rare in non-parous women [28, 30, 34]. The majority of participants in the analysed population, 81.5% in the urinary incontinence group and 80.35% in the prolapse group, had experienced at least two deliveries. A meta-analysis conductedby Schulten et al. indicated that having two or more deliveries significantly increases the risk of pelvic floor disorders, including urinary incontinence [31].

The analysis of delivery statistics revealed interesting differences between the types of pelvic floor dysfunctions. The percentages of women with one childbirth were similar in both groups. Among women with two births, SUI was more common than POP (52.6% vs. 45.78%), although this difference was not statistically significant (OR = 0.81; 95% CI: 0.25–2.64). Women with three or more births were more frequently diagnosed with POP, whereas SUI was more prevalent in women with five or six births. This suggests a potentially non-linear relationship between the number of births and the type of pelvic floor disorder. Due to the small sizes of some subgroups, it is not possible to draw definitive statistical conclusions. The findings indicate that the number of births alone is an insufficient predictor for a specific type

of pelvic floor dysfunction. The observed clinical variability suggests that additional factors should be considered, including the mother's age at the time of birth, BMI, hormonal status, genetic predispositions, and the method of delivery (vaginal vs. Caesarean section) [30, 32, 33].

It is important to note that the term "delivery" is broad and includes vaginal births without an episiotomy, instrumental deliveries using vacuum or forceps, and Caesarean sections. Each of these delivery methods can affect the levator ani and pubo-urethral fasciae to varying degrees, which are critical structures for maintaining continence [29]. A study conducted by Hagen et al. indicated that the risk for SUI increases not only with the number of births, but also with the time elapsed since the previous delivery [28].

Given these findings, prospective studies that consider often-overlooked variables seem warranted. Special attention should be given to factors such as the intervals between deliveries, the mother's age at her first delivery, lifestyle factors, the manner of delivery, the degree of soft tissue injury, and the potential influence of genetic factors [30, 33]. A comprehensive approach will enhance our better understanding of the pathophysiology of SUI and POP, leading to the development of more effective diagnostic and preventive strategies [29].

It is also important to highlight that this study does not include variables known to affect pelvic floor function such as birth weight, the manner of delivery, the duration of the second stage of delivery, and the quality of connective and collagen tissues. Incorporating these factors in future analyses will allow for a more accurate identification of risk factors and the mechanisms underlying SUI.

Body mass index (BMI)

According to the Main Statistical Office (GUS) and the National Health Fund (NFZ), between 39% and 42% of women in Poland are overweight, while 24-26% of adult women are classified as obese. Poland is among the leading European Union countries in terms of the rising rates of obesity, which results in serious health consequences, also in the area of urogynaecological health [35]. An increasing number of studies are highlighting the role of BMI as an independent and modifiable risk factor for pelvic floor disorders. A high MBI leads to chronically increased intra-abdominal pressure that stresses the pelvic support structures, particularly in the anterior compartment. This situation contributes to the development of cystoceles and stress urinary incontinence [36, 37].

In this study, 48.55% of overweight women were categorised in the urinary incontinence group, while 46.67% were categorised into the prolapse group. Among obese women (a BMI of 30 or higher), 28.32% were in the urinary incontinence group and 27.56% in the prolapse group.

The odd ratios were found to be 0.86 for overweight women and 0.87 for obese women; however, these values were not statistically significant (95% CI: 0.53–1.41 and 0.50–1.51, respectively). The observed trend suggests that a higher BMI may be a significant predisposing factor, especially for SUI. The lack of statistical significance could be attributed to a limited sample size or the presence of confounding variables.

International studies support the hypothesis that BMI has an independent influence on the risk for SUI. For instance, Dizdaroğulları et al. demonstrated that an increased BMI significantly correlates with urinary incontinence, even among non-parous women, indicating that its influence extends beyond perinatal factors [36]. Additionally, Oliveira et al. found that

obesity is a significant predictive factor for de novo SUI following pelvic floor reconstruction surgeries, adversely affecting treatment results [38].

A meta-analysis conducted by Wang et al. (2025) involving 13 studies revealed that a BMI of 24 kg/m² or higher significantly increases the risk for SUI. This association holds true regardless of age, hormonal status or education level [39]. Similarly, Khalil et al. found that obesity raises the risk for POP recurrence following surgeries, such as laparoscopic sacrocolpoplexy [40].

Dietz et al. documented the pathophysiological mechanisms involved, using transvaginal ultrasound to observe that women with a higher BMI experience greater elongation of the connective tissues surrounding the urethra and vaginal vestibule. These changes destabilise the continence mechanism, contributing to both SUI and cystoceles [41].

Additionally, a study by Fleecsa et al. involving women in Uganda confirmed a direct relationship between increased BMI and the frequency of both SUI and POP. Notably, the authors emphasised that the impact of BMI was independent of other sociodemographic factors [42].

Hamoda et al. demonstrated that women with a higher BMI experienced more severe symptoms of POP in the posterior vaginal wall area. This suggests that the location of prolapse may vary depending on a woman's BMI [37].

Therefore, preventing and treating obesity and overweight should be a key component of both primary and secondary strategies for preventing pelvic floor disorders. Furthermore, future studies should not only focus on BMI values but also examine fat distribution, body composition, levels of physical activity, and the presence of metabolic comorbidities. This comprehensive approach is essential to fully understand how body weight influences urogynaecological health.

Smoking

Regarding smoking, the relationship between smoking and pelvic floor disorders, such as pelvic organ prolapse and stress urinary incontinence, remains a controversial topic in the literature. In this study, 30.64% of participants with urinary incontinence and 32.44% of those with prolapse were smokers. Both percentages exceed the reference rate for the general female population in Poland, which is approximately 27% [43]. Despite a slightly higher prevalence among smokers, the differences were not statistically significant, indicating only a marginal trend.

Systematic reviews and cohort studies suggest that smoking may influence pelvic floor disorders through two main mechanisms: chronic cough, which increases intra-abdominal pressure and places a mechanical burden on pelvic support structures, and secondly, disruptions in collagen and elastin metabolism. Smoking negatively affects fibroblasts and the regenerative capacity of connective tissues, leading to weakened ligaments and pelvic floor fasciae.

Histological examinations have confirmed various mechanisms related to pelvic floor disorders. Salman et al. (2010) demonstrated a decreased density of collagen in the uterosacral ligaments of smokers [44]. Read (2008) reported clear symptoms of "herniosa" in smoking women with POP and SUI, attributing these symptoms to the chronic effects of smoke on tissue metabolism [45]. Baessler et al. and Sologuren-Garcia et al. suggested that smoking may increase the risk of complications following surgeries that use mesh, and can intensify the prolapse symptoms, particularly in elderly patients [46, 47].

A systematic review by Fitz et al., which included over 13,000 patients, indicated a significant association between smoking and an increased risk for SUI. However, this relationship appeared to weaken when considering factors such as BMI and age [48]. Some studies, including those by Rodríguez-Mias et al., found no significant associations and even suggested a potential protective effect. This discrepancy may stem from confounding variables, such as lower body weight, fewer childbirths, or higher levels of physical activity among the populations of smoking women [49]. Sheyn et al. pointed out that smoking women not only have a higher risk of developing SUI, but they are also more likely to require repeat surgery due to the recurrence of symptoms [50]. Thus, while smoking may not serve as a direct etiological factor in pelvic floor disorders, it likely acts as an intermediate modifier that exacerbates the impact of other variables, such as chronic cough, BMI, age, pulmonary diseases (e.g. COPD), or hypoxia. Our study's findings align with this pattern; and although they are statistically insignificant, they indicate a potential trend that warrants further directed research.

Conclusions

1. A potential risk factor for pelvic organ prolapse (POP) and stress urinary incontinence(SUI) involves various elements, including the method of delivery, the duration of the second stage of delivery, connective tissue characteristics, and others).
2. No significant correlation was found between the occurrence of miscarriages and the risk for POP and SUI was observed.
3. Our studies and existing literature show that a woman's first delivery is a crucial predictor of risk.
4. A high BMI is identified as an independent, modifiable risk factor for both POP and SUI.

References

1. Jiang, W.; Cheung, R.Y.K.; Chung, C.Y.; Chan, S.S.C.; Choy, K.W. Genetic Etiology in Pelvic Organ Prolapse: Role of Connective Tissue Homeostasis, Hormone Metabolism, and Oxidative Stress. Genes 2024, 16(1), 5.
2. Nygaard, I.E.; Bradley, C.S.; Brandt, D. Pelvic floor disorders and sexual function in older women. Obstet. Gynecol. 2020, 135(3), 568–577.
3. Kingsberg, S.A.; Wysocki, S. Managing urogenital atrophy and sexual health in postmenopausal women. Maturitas 2017, 96, 105–110.
4. Bergman, A. The pathophysiology of pelvic organ prolapse and stress urinary incontinence. Am. J. Obstet. Gynecol. 2020, 222(5), 493–498.
5. Kapoor, D.S.; Thakar, R.; Sultan, A.H. Obstetric risk factors for pelvic floor dysfunction. Best Pract. Res. Clin. Obstet. Gynaecol. 2022, 84, 32–43.
6. Rizk, D.E.E.; El-Sherbiny, W.; Al-Noman, S.; Bener, A.; Micallef, R.; Al-Shboul, Q. Clinical and urodynamic predictors of treatment outcome in women undergoing pelvic floor surgery. Int. Urogynecol. J. 2016, 27(2), 219–225.
7. Ismail, S.I.; Karmarkar, S.S.; Sohail, A. Contemporary approaches in the management of pelvic organ prolapse. Eur. J. Obstet. Gynecol. Reprod. Biol. 2024, 294, 30–38.
8. Jha, S. Modern surgical treatment of pelvic organ prolapse. Obstet. Gynaecol. 2021, 23(4), 244–252.

9. Hartigan, C.M.; Smith, A.L. Treatment strategies for pelvic organ prolapse. Curr. Urol. Rep. 2018, 19, 92.
10. Zhang, C.; Tang, Q.; Zhou, Y.; Fu, X.; Hu, P.; Liu, L. Histological and transcriptomic analysis of paravaginal and central defects in anterior vaginal wall prolapse: Insights from DeLancey's pelvic floor theory. Histol. Histopathol. 2021, 37(1), 71–82.
11. Polskie Towarzystwo Ginekologiczne. Poronienia – rekomendacje postępowania w przypadku poronień. Portal Medycyny Praktycznej, 2018. Available online: https://www.mp.pl/ginekologia/wytyczne/192296,poronienia (accessed on 12 May 2025
12. Puri, R. Risk factors for uterine prolapse among women in a hill village of Nepal: A case–control study. J. Obstet. Gynaecol. Res. 2011, 37(10), 1323–1330.
13. Paudel, R.; Bhandari, S.; Paudel, L.; Thapa, B.; Bista, K.D. Risk factors of uterine prolapse among reproductive age group women in rural Nepal: A community-based case–control study. Int. Urogynecol. J. 2019, 30(10), 1681–1688.
14. Siahkal, S.F., Iravani, M., Mohaghegh, Z., & Rashidi-Fakari, F. (2020). Maternal, obstetrical and neonatal risk factors' impact on female urinary incontinence: a systematic review. International Urogynecology Journal, 31(12), 2513–2523.
15. Kiliç, M. (2016). Incidence and risk factors of urinary incontinence in women visiting Family Health Centers. SpringerPlus, 5, 1331.
16. Abdullah, B., Ayub, S.H., Zahid, A.Z.M., & Noorneza, A.R. (2016). Urinary incontinence in primigravida: the neglected pregnancy predicament. European Journal of Obstetrics & Gynecology and Reproductive Biology, 200, 25–29.
17. Kapoor, D.S., Thakar, R., Sultan, A.H. (2017). Obstetric trauma and pelvic organ prolapse: is there an association? International Urogynecology Journal, 28(1), 43–51.
18. Fatima, A., Rehman, R., & Qureshi, R.N. (2025). Reproductive history and pelvic floor dysfunction: A cross-sectional study.
19. Shqara, M., Khalid, S., & Alam, H. (2024). Pelvic organ prolapse during pregnancy: a case-based observational analysis. Journal of Maternal-Fetal & Neonatal Medicine.
20. Główny Urząd Statystyczny. Zdrowie i ochrona zdrowia w 2023 roku. Warszawa: GUS, 2024. Available online: https://stat.gov.pl/obszarytematyczne/zdrowie/zdrowie/zdrowie-i-ochrona-zdrowia-w-2023-roku,1,14.html (accessed on 12 May 2025).
21. Repo, J. P., Rajavuori, A., Häkkinen, A., Palonen, P., & Kallinen, M. (2022). Maternal risk factors of urinary incontinence during pregnancy and postpartum: A prospective cohort study. European Journal of Obstetrics & Gynecology and Reproductive Biology, 266, 26–31.
22. Witkoś, J., & Hartman-Petrycka, M. (2020). Do future healthcare professionals have adequate knowledge about risk factors for stress urinary incontinence in women? BMC Women's Health, 20(1), 249.
23. Dai, S., Chen, H., & Luo, T. (2023).Prevalence and factors of urinary incontinence among postpartum: systematic review and meta-analysis.BMC Pregnancy and Childbirth, 23(1), 59.
24. Yang, Y. (2024). Collagen metabolism imbalance and oxidative stress in preterm birth and pelvic organ prolapse: Common mechanisms? (Manuscript in press)
25. Zhang, S., Li, B. S., Liu, J., Yang, L., Hong, L., & Li, H. (2024). The causal effect of reproductive factors on pelvic floor dysfunction: A Mendelian randomization study. BMC Women's Health, 24(1), 91.

26. Toloza, S. C. M., Cogollo, A. F. V., & García, K. M. P. (2024). Pelvic floor training to prevent stress urinary incontinence: A systematic review. Actas Urológicas Españolas, 48(2), 75–82.
27. Workineh, Z. A., Gashaw, Z. M., Andargie, T. M., et al. (2025). Symptomatic pelvic floor disorders in community-dwelling women in Central Gondar Zone, Northwest Ethiopia. International Urogynecology Journal.
28. Hagen, S., Sellers, C., Elders, A., et al. (2024). Urinary incontinence, faecal incontinence and pelvic organ prolapse symptoms 20–26 years after childbirth. BJOG: An International Journal of Obstetrics & Gynaecology.
29. Kearney, R., Salvatore, S., Khullar, V., et al. (2025). Do we have the evidence to produce tools to enable the identification and personalization of management of women's pelvic floor health disorders? Neurourology and Urodynamics. Wiley.
30. Sadakierska-Chudy, A., Szymanowski, P., et al. (2025). Whole Exome Sequencing for Pelvic Muscle Dysfunction in Young Women. International Urogynecology Journal.
31. Schulten, S. F. M., et al. (2022). Pelvic organ prolapse and prolapse recurrence: an updated systematic review and meta-analysis. Expert Reviews, PMC9296230.
32. Cai, S., Xia, M., Ding, Y., & Zeng, L. (2024). Clinical value of transperineal ultrasound in evaluating the effects of different delivery methods. Scientific Reports. Nature.
33. Silver, R. M. (2024). Neglected aspects of Obstetrics and Gynecology: Mental health, patient experience, implementation, and cost-effectiveness. BJOG: An International Journal of Obstetrics & Gynaecology, Advance Online Publication.
34. Hagenbeck, C., et al. (2025). Pelvic floor-related sexual functioning in the first 24 months postpartum. Acta Obstetricia et Gynecologica Scandinavica.
35. Główny Urząd Statystyczny. (2024). Zdrowie i ochrona zdrowia w 2023 roku. Warszawa: GUS. Pozyskano z: https://stat.gov.pl/obszary-tematyczne/zdrowie/zdrowie/zdrowie-i-ochrona-zdrowia-w-2023-roku,1,14.html
36. Dizdaroullar, G.E., Çam, Ç., Ayvac?, H. et al. (2025). The Importance of BMI on Prognostic Factors for Urinary Incontinence in Asymptomatic Nulliparous Women. Journal of Clinical Ultrasound.
37. Hamoda, R.E., Saad, E.A., Kamel, D.M. (2024). Impact of BMI on Vaginal Noise and POP Symptoms. Bulletin of Faculty of Physical Therapy.
38. Oliveira, I.K.B. et al. (2025). Occult UI, Diabetes, Obesity and Prolapse Severity as Risk Factors for De Novo SUI Post-Surgery. Neurourology and Urodynamics.
39. Wang, C., Wei, W., Ma, D. et al. (2025). Prevalence and Determinants of SUI in Middle-Aged Women: A Meta-Analysis. Archivos Españoles de Urología.
40. Khalil, N., El Kassis, N., Moubarak, M. et al. (2025). Impact of Age and BMI on Laparoscopic Mesh Sacrocolpopexy. Obstetrics and Gynecology International.
41. Dietz, H.P., Shek, K.L., Descallar, J. (2024). Levator–Urethra Gap and Individualized Cut-Offs. Ultrasound in Obstetrics & Gynecology.
42. Fleecs, J.D., Kiweewa, F.M. et al. (2024). Association Between Physical Activity and PFD in Parous Ugandan Women. International Urogynecology Journal.
43. Główny Urząd Statystyczny. (2021). Stan zdrowia ludności Polski w 2019 roku. Warszawa: GUS. Dostępne: https://stat.gov.pl/obszary-tematyczne/zdrowie/zdrowie/stan-zdrowia-ludnosci-polski-w-2019-r-,6,7.html
44. Salman, R. et al. (2010). Histological assessment of uterosacral ligaments in prolapse. International Urogynecology Journal.
45. Read, A. (2008). Signs of herniosis in women with vaginal prolapse and/or stress incontinence. Int Urogyn J.

46. Baessler, K. et al. (2023). Urinary incontinence and pelvic organ prolapse in women: prevention and treatment. Dtsch Arztebl Int.
47. Sologuren-García, G. et al. (2024). Epidemiology of pelvic floor dysfunction in the Tacna region of Peru. Int Urogynecol J.
48. Fitz, F.F., Bortolini, M.A.T. et al. (2023). Lifestyle and comorbidities as risk factors for pelvic organ prolapse: A systematic review. Int Urogynecol J.
49. Rodríguez-Mias, N.L. et al. (2015). Do POP and SUI share the same risk factors? Eur J Obstet Gynecol Reprod Biol.
50. Sheyn, D. et al. (2015). Tobacco use as a risk factor for reoperation in patients with SUI: EMR-based analysis. Int Urogynecol J.