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REVIEW PAPER / OBSTETRICS

Influence of pregnancy and mode of delivery on pelvic floor function: a review of literature

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ABSTRACT

Pelvic floor disorders (PFDs), such as pelvic organ prolapse (POP) and urinary incontinence (UI), severely affect women's quality of life. Among these, stress urinary incontinence (SUI) is the most common, impacting a significant proportion of women. In the US, the lifetime risk of undergoing surgery for UI or POP stands at 20%. Pregnancy-related factors, notably delivery method and UI occurrence during pregnancy, have a potent correlation with PFD onset. The pathophysiology of PFDs during pregnancy is complex, with factors like increased intra-abdominal pressure, changes in bladder neck mobility, and shifts in pelvic floor muscle strength and collagen metabolism playing pivotal roles. PFD risk factors span across pregnancy, labor, and the postnatal phase and include UI or fecal incontinence (FI) during pregnancy, advanced maternal age, elevated BMI, multiple births, instrumental and spontaneous vaginal deliveries, and newborns weighing over 4000 grams. Conversely, Cesarean deliveries are linked with a reduced long-term risk of UI and POP compared to vaginal births. Current prognostic models can predict the likelihood of PFD development based on variables such as delivery method, number of births, and familial history. Preventive measures encompass lifestyle changes like caffeine reduction and weight management,

alongside pelvic floor muscle training (PFMT) during pregnancy. Thus, expectant mothers are advised to participate in physical activities, prominently including PFMT.

Keywords: pelvic floor disorders; mode of delivery; urinary incontinence; pelvic organ prolapse

EPIDEMIOLOGY OF PELVIC FLOOR DISORDERS IN THE PERINATAL PERIOD

Proper pelvic floor function is an important factor that determines the quality of life and well-being of women. Pelvic floor disorders (PFDs) such as pelvic organ prolapse (POP), urinary incontinence (UI), or fecal incontinence (FI) can significantly diminish a patient's quality of life [1]. The distinction between proper and impaired function isn't always clear-cut; it often hinges on individual perceptions, or the criteria employed. This variability partly explains the significant discrepancies in epidemiological data across studies.

Stress urinary incontinence (SUI) stands out as the most prevalent PFD, affecting 33.5% up to 45.9% of women, followed by urgency, and mixed UI with prevalence rates of 31.1% and 18.1% respectively [1, 2]. The lifetime hazard for either incontinence or prolapse surgery in the US population was estimated at 20% [3, 4].

Pelvic floor disorders are strongly correlated with pregnancy-related factors such as pregnancy itself, mode of delivery including instrumental deliveries, UI during pregnancy, episiotomy, and prolonged second stage of labor [5].

The prevalence of UI among pregnant women varies from 9% to 75% and rises with gestational age. Prevalence of SUI episodes among pregnant women are ranged from 18.6 % to 60 %, UUI from 2 % to 35 %, and MUI from 3.8 % to 13.1 % [6]. Pregnancy itself increases the prevalence of urinary incontinence from 20.1% in nulliparous women to 30.1% in primiparous women who delivered by cesarean section in the short-term, while the long-term influence remains unclear [7].

Reimers et al describe a decrease in prevalence during postpartum from 10% at 6 weeks to 2% at 12 months after vaginal delivery. Authors also suggest that these women might be at higher risk of developing POP [8].

Pares et al estimated episodes of fecal incontinence during pregnancy among a cohort of 228 women at 40.8% (9.2% of stool incontinence and 15 patients with solid stool, 6 patients with liquid stools, and 31.6 % of flatus incontinence) which notably impacts the quality of life [9].

After first childbirth, stress urinary incontinence and pelvic organ prolapse affect 34.3% and 30% of women respectively, with a lower hazard of pelvic floor disorders associated with cesarean than vaginal delivery. In addition, instrumental vaginal delivery relates to a higher risk of POP [10].

PATHOGENESIS OF PELVIC FLOOR DISORDERS IN THE PERINATAL PERIOD

Impairment of normal pelvic floor function during pregnancy is multifactorial. Mechanical and hormonal changes during pregnancy and delivery contribute to the development of PFDs. Increasing body weight during pregnancy and the enlarging uterus are leading to increase intra-abdominal pressure, which causes overloading of the pelvic floor muscles and ligaments. The bladder neck mobility (BNM) is increased, which is a consequence of the widened retrovesical angle, which is strongly associated with the onset of UI [11].

Shek et al compared a cohort of 688 pregnant women in the late 3rd trimester to 74 non-pregnant nulliparous. The study revealed a 27% increase in the hiatus area (HA) at rest and a 41% increase in HA during the Valsalva maneuver. There was also a generalized increase in segmental urethral mobility by 0.67 to 1.01 cm corresponding to a 64 % to 91 % increase in late pregnancy [12]. Similar results were shown in the Staer-Jensen et al. [13] study, where 274 nulliparous pregnant women were examined at 21 and 37 weeks of gestation. The authors showed a significant increase for all levator hiatus dimension measurements between 21 and 37 weeks of gestation. The most marked change was found for the levator hiatus area at rest and during the Valsalva maneuver. Bladder neck mobility changed significantly during pregnancy. The most marked change was seen from rest to contraction [13].

Chan et al. [14] study on 405 pregnant women across all trimesters demonstrated significant descent of the bladder neck (BN), cervix, and anorectal junction progressing with the advancement of pregnancy. They found the descent of BN at Valsalva, increase in HA at contraction and increase in maternal age as SUI risk factors. The descent of the anorectal junction and increase in HA at rest were factors for prolapse symptoms in the second and third trimesters, respectively [14].

Mørkved et al. [15] have found a decrease in pelvic floor muscles (PFM) strength and thickness in pregnant women with SUI compared to continent nulliparous pregnant women. Observed changes may have a serious impact on quality of life. Cetindag et al. [16] demonstrated increasing descent of all POP-Q points of the vaginal wall (Aa, Ap, Ba, Bp, C in 33 nulliparous pregnant women which was also correlated with worsening POP symptoms assessed by Pelvic Floor Distress Inventory-Short Form (PFDI-20).

Another PFDs etiological factor that was assessed was hormonal status during pregnancy.

In a prospective longitudinal study, Coll et al. [17] found the risk of developing SUI throughout pregnancy is higher in women with higher progesterone levels in the first trimester.

Kamisan et al. [18] compared 129 nulliparous to 113 who underwent only cesarean section (CS) deliveries. Compared to nulliparas, women who delivered exclusively by CS presented increased pelvic organ descent on Valsalva and tissue displacement on pelvic floor muscle contraction implying increased tissue elasticity, compliance, or reduced stiffness. The authors suggest the observed difference might be the result of the hormonal and/or mechanical effect of pregnancy [18].

In some studies, it was observed that POP and SUI are associated with alterations in the metabolism of collagen, which is the main component of the intra-pelvic fascia. Jackson et al. [19] compared eight patients with genitourinary prolapse with a control group. They observed in prolapse tissue a significant reduction in total collagen, a significant rise in the intermediate cross-links Δ-HLKUL, and an increase of the advanced glycation end product pentosidine. There was no difference in elastin content between prolapse and control tissues [19]. Keane et al. [20] compared 36 nulliparous women with genuine SUI with 25 controls. In the group of patients with SUI, significantly reduced collagen content was observed in the endopelvic fascia. In addition, there was a decreased ratio of type I to type III collagen, and the cross-link content in the collagen matrix was also significantly reduced in the SUI group [20].

Risk factors for pelvic floor disorders during pregnancy, labor, and the postnatal period.

Hage Fransen et al. [21] in their systematic review found that pregnancy related risk factors for urinary incontinence are urinary incontinence during pregnancy, instrumental vaginal delivery, episiotomy, tears and constipation [odds ratio (OR) 1.55; 95% confidence interval (CI): 1.20–2.00] [21]. Respectively pregnancy related risk factors for fecal incontinence are fecal incontinence during pregnancy, maternal age over 35, prenatal body mass index over 30, instrumental vaginal delivery, a spontaneous vaginal delivery, oxytocin augmentation and the weight of the newborn higher than 4000 grams [21]. Study on a cohort of 300 Austrian women recruited in either the first or third trimester showed that family history, high body mass index (BMI), and multiple pregnancies were independently associated with pelvic floor symptoms during pregnancy [22].

Kenne et al. [23] in their study showed that increasing parity is associated with POP (OR 1.155; 95% CI: 1.020–1.300; $p = 0.020$), whereas higher BMI is associated with greater risk of UI (OR 1.038, by one BMI unit, 95% CI: 1.033–1.043; $p < 0.001$). Older age is associated with all types of PFD (OR 1.021, per one year age, 95% CI: 1.020–1.023; $p < 0.001$) [23].

IMPACT OF DELIVERY MODE ON PELVIC FLOOR DISORDERS

The support of the pelvic organs' changes both during pregnancy and after natural delivery and cesarean section. The finding shows the natural delivery group has more pronounced changes in POP-Q scale measurements compared with the cesarean delivery group in the postpartum period. Most of the POP-Q scale measurements returned to pre-pregnancy values 6 months after delivery. The only measurement that differed from the pre-pregnancy value was the lower cervix position in the natural delivery group [8].

In a systematic review and meta-analysis by Hage Fransen et al. [21], the incidence of urinary incontinence in short and long-term follow-ups was compared. The study shows that, when comparing the groups after natural delivery and cesarean section, there was a significantly higher probability of urinary incontinence after a natural delivery, immediately after delivery, 2–18 months, and 2–12 years after delivery. The highest risk of postpartum urinary incontinence was observed in women who developed this condition during pregnancy. The same seems to hold for POP. POP during pregnancy was highly associated with postpartum POP OR 8.2 (95% CI: 3.07–21.9) [21].

In a long term, the mode of delivery has a significant impact on pelvic floor function. Bloomquist et al analyzed a cohort of 1528 women 5–10 years after their first delivery and followed up annually for 9 years (778 in the cesarean birth group, 565 in the spontaneous vaginal birth group, and 185 in the operative vaginal birth group). For spontaneous vaginal delivery the 15-year cumulative incidences of pelvic floor disorders after first delivery were as follows: SUI, 34.3%; OAB, 21.8%; fecal incontinence (FI), 30.6%; and POP, 30.0%. Compared with spontaneous vaginal delivery, cesarean delivery was associated with a significantly lower hazard of SUI, OAB, and POP, while operative vaginal delivery was associated with a significantly higher hazard of AI and POP [10].

Systematic review and meta-analysis by Keag et al. [24] which included patients from high-income countries showed that compared to vaginal delivery, cesarean delivery was associated with decreased risk of urinary incontinence, odds ratio (OR) 0.56 (95% CI 0.47 to 0.66; $n = 58{,}900$; 8 studies) and pelvic organ prolapse (OR 0.29, 0.17 to 0.51; $n = 39{,}208$; 2

studies). [24]. Gyhagen et al. investigate the prevalence and risk factors for symptomatic pelvic organ prolapse (sPOP) and sPOP concomitant with urinary incontinence (UI) in women 20 years after one vaginal delivery or one cesarean delivery. Prevalence of POP was more than twice times higher after vaginal delivery compared with cesarean section (14.6 versus 6.3%, odds ratio 2.55; 95% CI: 1.98–3.28) but was not increased after emergency compared to elective cesarean section [25].

The study by Friedman et al. [26] showed that mode of delivery affects the strength of the pelvic floor muscles. It is reduced after a natural delivery, and even more reduced after forceps delivery when compared to the cesarean section group. Strength is associated with FI and POP 6–11 years after delivery [26]. In the study of Blomquist et al, it was demonstrated that among women with at least 1 vaginal delivery reduction in pelvic floor muscle strength (< 20 cm H_2O in perineometry) was associated with a shorter time to first event of SUI, OAB, and POP [27].

PREDICTIVE FACTORS AND PREVENTIVE MEASURES

Jelovsek et al. [28] created a prognostic model to estimate 12- and 20-year risk of PFDs based on two prospective cohort studies from Sweden (the SwePOP cohort, n = 4991) and Scotland/New Zealand (ProLong cohort, n = 3638). Based on the model for 1 primiparous woman of average risk 9 cesarean deliveries would be necessary to prevent urinary incontinence. Route of delivery, number of previous births, and family history of each pelvic floor disorder were the most influential elements. Models are provided at http://riskcalc.org/UR_CHOICE/ [28].

Cesarean section performed at scheduled or before the second stage of labor was found to have a protective effect against PFDs compared with vaginal deliveries. Prolong vaginal deliveries in second stage may cause denervation of the pelvic floor and damage its function, later, therefore cesarean delivery performed during the second stage of labor has a nonsignificant protective effect against the later development of pelvic floor disorders [29, 30].

Knowing the risk factors, we can identify a group of women at risk of developing PFD later in life and targeted prevention strategies can be initialized with the aim to help prevent or reduce the risk such as supervised pelvic PFMT and/or pessary placement [21].
Research by Wang et al. [31] shows that lifestyle changes (*e.g*. caffeine control) and proper exercise prevent urinary incontinence in pregnancy and thus reduce the risk of UI later in life.

In an overweight or obese group of women, a 3–5% weight loss can reduce urinary incontinence symptoms by up to 50% [32].

Actions such as screening for bladder-neck mobility, digital control of pelvic floor contractility at mid-pregnancy, and proper history taking (*i.e.*, Incontinence Impact Questionnaire) allow identifying women at high risk of developing PFDs Pelvic floor training is effective in decreasing the prevalence and/or severity of UI and POP during pregnancy and in the postpartum period [6]. Some research shows that PFMT can reduce or eliminate symptoms of all types of urinary incontinence. Both the leak volume and the frequency of leak episodes were significantly reduced. In the group of women who regularly exercised their pelvic floor muscles, the need for further treatment was much less frequent [33].

Nygaard al. [34] confirm that pregnant women should be physically active and recommends including PFMT in antenatal exercise classes [29].

CONCLUSIONS

In conclusion, the significance of PFDs in perinatal period and the importance and understanding of risk factors and implementing prevention strategies should be highlighted. Identifying patients at higher risk and promoting lifestyle changes and PFMT, healthcare professionals can help reduce the incidence and impact of these disorders on women's lives.

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Article information and declarations

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Justyna Zarzecka — project development, data collection, manuscript writing.

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Ewa Barcz — project development, manuscript editing, data analysis.

Andrzej Pomian — concept, project development, mansucript writing, data analysis.

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Conflict of interest

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Supplementary material

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