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# Pelvic organ prolapse and incontinence 15–23 years after first delivery: a cross-sectional study

**I Volløyhaug,[a,b] S Mørkved,[c] Ø Salvesen,[d] KÅ Salvesen[a,e]**

[a] Department of Laboratory Medicine, Children's and Women's Health, Norwegian University of Science and Technology, [b] Department of Obstetrics and Gynaecology, Trondheim University Hospital, [c] Department of Public Health and General Practice, Norwegian University of Science and Technology, [d] Department of Cancer Research and Molecular Medicine, Norwegian University of Science and Technology, Trondheim, Norway [e] National Center for Fetal Medicine, Trondheim University Hospital, Trondheim, Norway
*Correspondence:* I Volløyhaug, Department of Laboratory Medicine, Children's and Women's Health, NTNU, Faculty of Medicine, P.O. Box 8905, Medisinsk Teknisk Forskningssenter, 7491 Trondheim, Norway. Email ingrid.volloyhaug@ntnu.no

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**Objective** To study the association between pelvic floor dysfunction (PFD) and mode of delivery and to calculate the risks of PFD comparing caesarean delivery and operative vaginal delivery to normal vaginal delivery 15–23 years after childbirth. A subgroup analysis comparing forceps and vacuum delivery was planned.

**Design** Cross-sectional study.

**Setting** Postal questionnaire.

**Population** 1641 (53%) of 3115 women who delivered their first child in Trondheim, Norway, between January 1990 and December 1997.

**Methods** A questionnaire including questions on symptomatic pelvic organ prolapse, urinary and fecal incontinence and surgery for these conditions.

**Main outcome measures** Prevalence of PFD measured by symptomatic pelvic organ prolapse or surgery (sPOP), urinary incontinence or surgery (UI) and fecal incontinence or surgery (FI).

**Results** When caesarean delivery was compared to normal vaginal delivery the adjusted odds ratio (aOR) for sPOP was 0.42 (95% confidence interval, CI, 0.21–0.86) and the aOR for UI was 0.65 (95% CI 0.46–0.92). Operative vaginal delivery was associated with increased risk of sPOP (aOR 1.73, 95% CI 1.21–2.48) and FI (aOR 1.96, 95% CI 1.26–3.06) when compared with normal vaginal delivery. There were no differences in sPOP, UI or FI in a subgroup analysis comparing forceps and vacuum delivery.

**Conclusions** Caesarean delivery was associated with decreased risk and operative vaginal delivery with increased risk of pelvic floor dysfunction 15–23 years after first delivery, but there were no differences between forceps and vacuum delivery.

**Keywords** Fecal incontinence, forceps delivery, pelvic floor dysfunction, pelvic organ prolapse, urinary incontinence, vacuum delivery.

**Linked article** This article is commented on by R Rogers. To view this mini commentary visit http://dx.doi.org/10.1111/1471-0528.13318.

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## Introduction

Pelvic floor dysfunction (PFD) includes symptoms of pelvic organ prolapse, urinary incontinence and fecal incontinence. PFD impacts daily life activities, sexual function and ability to perform exercise in many women, and the economic costs for individuals and society are high. A large number of women will have symptoms of PFD receiving conservative treatment or not even seeking professional health care[1–4] and 11–21% of women in western countries will undergo surgery for pelvic organ prolapse and urinary incontinence during their life time.[5–9]

The prevalence of PFD varies widely according to the population studied and the definition used[10] and is reported to be 3–12% for symptomatic pelvic organ prolapse, 15–35% for urinary incontinence and 3–14% for fecal incontinence.[11–20] Overlapping of symptoms of two or three conditions is common.[11,12,19,20] The prevalence of PFD is influenced by several risk factors such as age, body mass index, parity and ethnicity.[11–25]

 

Pelvic floor dysfunction prevalence increases with advancing age,[11–16,19–22] and symptoms of PFD will usually appear several years after delivery. Mode of delivery is associated with the prevalence of PFD. Previous studies have shown that caesarean delivery is associated with lower prevalence of PFD in later life[17,18,21,22] and some studies have suggested that operative vaginal delivery is associated with increased prevalence of prolapse and incontinence. However, this is controversial, and the distinction between forceps and vacuum deliveries has only been made in two small studies.[26,27] An association between operative vaginal delivery and PFD could be explained by excessive injury to the pelvic floor muscles during an operative vaginal delivery,[28] and muscle trauma is associated with a higher prevalence of PFD.[29] Arguably, forceps delivery carries higher risk of damage to pelvic floor structures than vacuum delivery, because the forceps branches may damage muscles, nerves and connective tissue in the birth canal.

The aim was to study the association between pelvic floor dysfunction (PFD) and mode of delivery and to calculate the risks of PFD comparing caesarean delivery and operative vaginal delivery with normal vaginal delivery 15–23 years after first delivery. A subgroup analysis was performed to study possible risk differences between forceps and vacuum delivery.

## Methods

We conducted a cross-sectional study among 3115 women who delivered their first child at Trondheim University Hospital, Norway, between 1990 and 1997. Operative vaginal delivery assisted by forceps or vacuum was performed at approximately the same rate during this time period (forceps around 3% and vacuum in 3–5% of all deliveries).

We defined three main study groups; normal vaginal delivery (NVD), caesarean delivery (CD) and operative vaginal delivery (OVD), and the last group was divided into forceps delivery (FD) and vacuum delivery (VD) for subgroup analysis. Women were allocated to groups considering all their deliveries (the first delivery in 1990–97 and all subsequent deliveries) and were placed in the delivery group that was likely to have caused most harm to the pelvic floor: CD < NVD < OVD. Women in the CD group had only delivered by caesarean section and never had a vaginal delivery. Women in the NVD group had at least one normal vaginal delivery (including deliveries with oxytocin augmentation, epidural analgesia, episiotomy and/or perineal tears) and other deliveries could be NVD or CD, but not OVD. A group of 195 women were allocated to the NVD group after previous CD. Women in the OVD group had delivered by either forceps or vacuum or both, and other deliveries could be any mode of delivery (NVD, CD or OVD). In the subgroup analysis, we divided women into an FD group and a VD group according to their first delivery. We excluded women with prior NVD ($n = 8$) or CD ($n = 28$) and women having had both vacuum and forceps ($n = 22$), but not women with subsequent same type of OVD, NVD or CD.

A power calculation was based on previous studies of urogynaecological patients indicating a higher risk of pelvic floor muscle trauma after forceps delivery,[28] and a study demonstrating that ultrasound verified muscle trauma doubled the risk for pelvic organ prolapse.[29] We assumed a prevalence of sPOP of 12.0% in the OVD group and 5.5% in the NVD group and found that 296 women in each group would be sufficient to detect a statistically significant ($P < 0.05$) and clinically relevant difference between groups with power 80%. The prevalence of UI is higher than for sPOP and the FI prevalence is similar to sPOP. Thus, the study should be sufficiently powered to detect clinically important differences between groups for UI and FI as well.

Primiparous women delivering at Trondheim University Hospital between 1 January 1990 and 31 December 1997, who had postal address in Norway in 2013, were identified from the Hospital Patient Administrative System. We included all primiparous women with OVD or CD during 1990–97, and all primiparous women with NVD from 1 January to 1 July of each calendar year, to include a similar number of women with NVD stratified by year of first delivery. Exclusion criteria were stillbirth, breech delivery and infant birthweight <2000 g at the index birth, but women were not excluded if these conditions occurred in subsequent pregnancies. Informed consent was obtained from all participants included in the study. The study was approved by the Regional Committee for Medical and Health Research Ethics (REK midt 2012/666).

A postal questionnaire was sent to 3115 women in March 2013 with two further mailing cycles in June and September 2013 to non-responders. The questionnaire included questions about all their deliveries (parity, infant birthweight and delivery method), menopause and use of hormone replacement therapy, weight, height, smoking habits, chronic coughing, hysterectomy and surgery for pelvic organ prolapse, urinary and fecal incontinence. Information about perineal tears and indication for OVD at first delivery was obtained from the hospital records. Additional information about subsequent deliveries (delivery mode, infant birthweight, head circumference, parity, elective or emergency CD, and year of delivery) was obtained from the Norwegian Medical Birth Registry. Information from the questionnaires regarding delivery method and infant birthweight was cross-checked with the Hospital Patient Administrative System and the Norwegian Medical Birth Registry. After this comparison there was a discrepancy for mode of first delivery in 13 women, and individual hospital records were scrutinised and delivery mode confirmed.

The questionnaire included a Norwegian translation of the Pelvic Floor Distress Inventory (PFDI-20).[30] Diagnosis of symptomatic pelvic organ prolapse, urinary and fecal incontinence was based on five key questions from the PFDI-20. A positive response to 'seeing or feeling a vaginal bulge' qualified for the diagnosis of symptomatic pelvic organ prolapse. Positive response to 'urinary incontinence at urgency' or 'urinary incontinence at coughing, sneezing, laughing' qualified for the diagnosis of urinary incontinence and positive response to 'incontinence for loose stool' or ' incontinence for well-formed stool' qualified for the diagnosis of fecal incontinence, counting any positive response as diagnostic without regard to severity of symptoms.

The main outcome variables were three composite variables consisting of symptoms and/or having had surgery:

1 Symptomatic pelvic organ prolapse and/or current use of ring pessary and/or having had surgery for pelvic organ prolapse (sPOP)
2 Urge and/or stress urinary incontinence and/or having had surgery for urinary incontinence (UI)
3 Incontinence for loose and/or well-formed stool and/or having had surgery for fecal incontinence (FI)

For the subsequent paragraphs the abbreviations sPOP, UI, and FI indicate both symptomatic women and/or women having had previous surgery for these conditions.

### Statistical methods

Statistical analysis was performed with IBM SPSS statistics version 21.0 (IBM SPSS, Armonk, NY, USA). To identify any differences between study groups in demographics and clinical background data, we used the two-sample *t*-test for continuous variables and the chi-square test for categorical variables. The prevalence of the outcome variables was compared between CD, OVD and NVD, and in a subgroup analysis FD was compared with VD. $P < 0.05$ was considered statistically significant.

The main outcome variables (sPOP, UI, FI) were analysed using univariable logistic regression for calculation of crude odds ratios (cOR) for delivery modes. In addition, multivariable logistic regression analysis was used to correct for possible confounding factors and calculate adjusted odds ratio (aOR) with 95% confidence intervals (CI). On the basis of clinical knowledge and results from previous studies, we selected parity, maternal age at delivery, current body mass index (BMI), hysterectomy, menopause, smoking habits, chronic coughing and infant birthweight (the largest infant delivered by each woman) as possible confounders. Univariable logistic regression was used to test their association to main outcome variables one by one before entering into the multivariable regression model. The woman's age in 2013 was omitted from the model because of correlation with age at delivery and menopause. Head circumference was omitted because of correlation to birthweight. Smoking and chronic coughing were independent variables and both were entered into the final regression model. A small percentage of the women provided reliable information on the use of hormone replacement therapy, and therefore no analysis was done for this potential confounder.

For comparison of FD and VD the following potential confounders were added into the model; indication for OVD (fetal distress or prolonged second stage of labour), perineal tears grade 3–4, and the largest infant delivered vaginally, excluding infants delivered by caesarean section.

When data were missing, those cases were omitted, and analyses were run on study participants who had responded to the actual question.

## Results

In all, 1641 (53%) of 3115 invited women agreed to participate in the study. A flow-chart of study participants is presented in Figure 1. The response rate was similar for all delivery groups (NVD 51.1%, FD 53.1%, VD 57.2%, CD 51.6%) but it was slightly higher in the VD compared with NVD ($P = 0.02$) and CD groups ($P = 0.04$).

Demographics and clinical background data are given in Table 1. Non-responders had a mean age 46 years (SD 5) and were significantly younger than responders (mean age 47 years, $P < 0.01$). Also more non-responders lived a long distance from Trondheim in 2013 according to their postal code (16.7% versus 13.0%, $P < 0.01$). Further data for comparison of non-responders were not available.

Overall, the prevalence of the main outcomes were: sPOP 10.9% (172/1580), UI 46.9% (752/1603) and FI 9.1% (145/1594). In all, 46.9% (727/1549) of women were asymptomatic 15–23 years after their first delivery. The

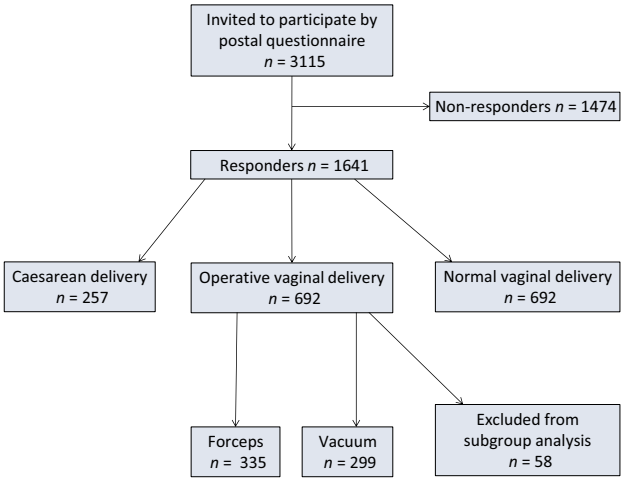


**Figure 1.** Flow chart of study participants. Excluded from subgroup analysis $n = 58$ (8 after previous NVD, 28 after previous CD, 8 FD after previous VD and 14 VD after previous FD).

**Table 1.** Demographics and clinical background data. Mean and standard deviation for continuous variables. Percent and number for categorical variables

| **Continuous variables** | **Normal vaginal delivery (NVD) *n* = 692** | **Caesarean delivery (CD) *n* = 257*** | **Operative vaginal delivery (OVD) *n* = 692** | **Vacuum (VD) *n* = 299** | **Forceps (FD) *n* = 335** | **Total *n* = 1641** | **T-test CD versus NVD *P*** | **T-test OVD versus NVD *P*** | **T-test FD versus VD *P*** |
|---|---|---|---|---|---|---|---|---|---|
| Age 2013 (years), *n* = 1641 | 46.52 (4.47) | 49.63 (5.46) | 47.16 (4.75) | 46.99 (4.89) | 47.48 (4.67) | 47.28 (4.87) | <0.01 | 0.01 | 0.20 |
| Age at 1st delivery (years), *n* = 1641 | 26.74 (4.10) | 29.80 (5.22) | 27.81 (4.30) | 27.85 (4.34) | 27.97 (4.29) | 27.67 (4.50) | <0.01 | <0.01 | 0.73 |
| Parity, *n* = 1641 | | | | | | | | | |
| No. of children | 2.47 (0.77) | 1.90 (0.84) | 2.24 (0.79) | 2.24 (0.79) | 2.18 (0.81) | 2.28 (0.81) | <0.01 | <0.01 | 0.33 |
| No. of deliveries | 2.44 (0.77) | 1.80 (0.82) | 2.20 (0.79) | 2.21 (0.78) | 2.16 (0.82) | 2.24 (0.81) | <0.01 | <0.01 | 0.41 |
| Largest infant's birth weight (g), *n* = 1641 | 3837.73 (475.64) | 3648.75 (669.92) | 3899.91 (490.82) | 3922.44 (480.00) | 3833.09 (481.49) | 3834.36 (523.57) | <0.01 | 0.02 | 0.02 |
| Head circumference largest infant (cm), *n* = 1640 | 36.24 (1.30) | 36.29 (1.69) | 36.62 (1.47) | 36.79 (1.53) | 36.44 (1.38) | 36.41 (1.45) | 0.63 | <0.01 | <0.01 |
| BMI (kg/m$^2$), *n* = 1608 | 25.45 (4.33) | 26.51 (5.25) | 25.97 (4.69) | 25.95 (4.84) | 25.92 (4.61) | 25.83 (4.65) | <0.01 | 0.04 | 0.93 |
| **Categorical variables** | | | | | | | **$\chi^2$-test CD versus NVD *P*** | **$\chi^2$-test OVD versus NVD *P*** | **$\chi^2$-test FD versus VD *P*** |
| Menopause, *n* = 1499 | 14.2% (91/639) | 33.9% (79/233) | 20.6% (129/627) | 19.2% (51/266) | 22.1% (67/303) | 19.9% (299/1499) | <0.01 | <0.01 | 0.39 |
| Hysterectomy, *n* = 1632 | 3.1% (21/688) | 7.1% (18/254) | 3.5% (24/690) | 2.7% (8/299) | 4.5% (15/334) | 3.9% (63/1632) | <0.01 | 0.66 | 0.22 |
| Smoking, *n* = 1630 | 16.4% (113/689) | 20.6% (52/253) | 19.2% (132/688) | 19.4% (58/299) | 19.2% (64/333) | 18.2% (297/1630) | 0.14 | 0.18 | 0.96 |
| Chronic coughing, *n* = 1630 | 4.1% (28/690) | 2.4% (6/252) | 4.8% (33/688) | 4.0% (12/299) | 5.7% (19/332) | 4.1% (67/1630) | 0.22 | 0.51 | 0.32 |
| Perineal tear grade 3–4**, *n* = 634 | | | | 9.7% (29/299) | 11.0% (37/335) | | | | 0.58 |
| Prolonged 2nd stage of labour**, *n* = 634 | | | | 53.8% (161/299) | 46.0% (154/335) | | | | 0.05 |
| Fetal distress during labour**, *n* = 634 | | | | 35.1% (105/299) | 43.6% (146/335) | | | | 0.03 |

*Elective CD *n* = 76 (29.6%), Emergency CD *n* = 181 (70.4%).

**Prevalence of perineal tears, prolonged second stage and fetal distress during labour was calculated only by analysis of FD and VD groups.

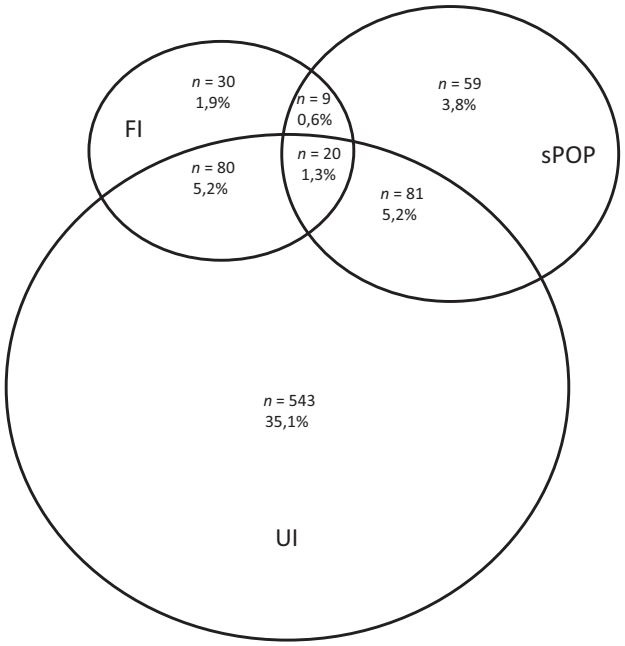


**Figure 2.** Prevalence of symptomatic pelvic organ prolapse (sPOP), urinary incontinence (UI) and fecal incontinence (FI) and overlap of pelvic floor disorders among 1549 women who responded to all three questions.

prevalence of single PFD and overlaps of two or three PFDs are presented in Figure 2.

Prevalence of none (asymptomatic women), one, two and three pelvic floor disorders for NVD, CD and OVD, and crude and adjusted odds ratios for these conditions are presented in Table 2. When CD was compared with NVD the adjusted odds ratio (aOR) for sPOP was 0.42 (95% CI 0.21–0.86) and for UI 0.65 (95% CI 0.46–0.92). OVD increased the risk of sPOP (aOR 1.73, 95% CI 1.21–2.48) and FI (aOR 1.96, 95% CI 1.26–3.06) compared with NVD. There was a higher prevalence of asymptomatic women in the CD group (aOR = 1.74, 95% CI 1.23–2.45) and higher prevalence of women with two PFDs in the OVD group (aOR = 1.60, 95% CI 1.09–2.33) when compared to NVD.

Table 3 presents the prevalence, cOR and aOR of PFD in the FD and VD groups. There were no differences between groups.

Analyses of possible confounders are presented in Supporting Information Table S1. In addition to delivery mode, chronic coughing was a significant contributing risk factor for sPOP in a multivariable logistic regression analysis (aOR 2.33, 95% CI 1.22–4.46). BMI was a borderline significant risk factor for sPOP (aOR 1.03, 95% CI 1.00–1.07) and was statistically significant for UI (aOR 1.09, 95% CI 1.06–1.12). Parity and the largest infant's birthweight were additional independent risk factors for UI but did not remain significant in a multivariable logistic regres-

**Table 2.** Prevalence of pelvic floor disorders. Crude odds ratio (cOR) with 95% confidence interval (CI) from univariable logistic regression analysis to test for differences in prevalence of main outcome variables. Adjusted odds ratio (aOR) with 95% confidence interval (CI) from multivariable logistic regression after correction for mother's age at delivery, parity, largest infant's birthweight, BMI, smoking, chronic coughing, menopause and hysterectomy

| | Normal vaginal delivery | Caesarean delivery | Operative vaginal delivery | Caesarean delivery versus normal vaginal delivery | | Operative vaginal delivery versus normal vaginal delivery | |
|---|---|---|---|---|---|---|---|
| | | | | cOR (CI) | aOR (CI) | cOR (CI) | aOR (CI) |
| **Pelvic floor disorder** | | | | | | | |
| Symptomatic pelvic organ prolapse | 9.2% (61/666) | 4.5% (11/245) | 14.9% (100/669) | 0.47 (0.24–0.90) | 0.42 (0.21–0.86) | 1.74 (1.24–2.45) | 1.73 (1.21–2.48) |
| Urinary incontinence | 47.8% (323/676) | 39.4% (99/251) | 48.8% (330/676) | 0.71 (0.53–0.96) | 0.65 (0.46–0.92) | 1.04 (0.84–1.29) | 0.97 (0.77–1.23) |
| Fecal incontinence | 6.1% (41/671) | 8.9% (22/246) | 12.1% (82/677) | 1.51 (0.88–2.59) | 1.10 (0.58–2.11) | 2.12 (1.43–3.13) | 1.96 (1.26–3.06) |
| **Number of pelvic floor disorders** | | | | | | | |
| 0 | 48.1% (313/651) | 57.7% (139/241) | 41.9% (275/657) | 1.47 (1.09–1.98) | 1.74 (1.23–2.45) | 0.78 (0.63–0.97) | 0.83 (0.66–1.06) |
| 1 | 42.4% (276/651) | 33.2% (80/241) | 42.0% (276/657) | 0.68 (0.50–0.92) | 0.62 (0.44–0.89) | 0.98 (0.79–1.23) | 0.94 (0.74–1.20) |
| 2 | 8.8% (57/651) | 8.3% (20/241) | 14.2% (93/657) | 0.94 (0.55–1.61) | 0.81 (0.44–1.47) | 1.72 (1.21–2.44) | 1.60 (1.09–2.33) |
| 3 | 0.8% (5/651) | 0.8% (2/241) | 2.0% (13/657) | 1.08 (0.21–5.61) | 0.85 (0.14–5.21) | 2.61 (0.92–7.36) | 2.58 (0.79–8.37) |

**Table 3.** Prevalence of pelvic floor disorders in the forceps and vacuum delivery groups. Crude odds ratio (cOR) with 95% confidence interval (CI) from univariable logistic regression analysis to test for differences in prevalence. Adjusted odds ratio (aOR) with 95% confidence interval (CI) from multivariable logistic regression after correction for mothers age at delivery, parity, largest infant's birthweight, BMI, smoking, chronic coughing, menopause, hysterectomy, perineal tears grade 3–4, prolonged 2nd stage of labour and fetal distress during labour

| | Vacuum delivery | Forceps delivery | Forceps delivery versus vacuum delivery | |
|---|---|---|---|---|
| | | | cOR (CI) | aOR (CI) |
| **Pelvic floor disorder** | | | | |
| Symptomatic pelvic organ prolapse | 14.9% (43/289) | 15.7% (51/325) | 1.07 (0.69–1.66) | 0.89 (0.56–1.43) |
| Urinary incontinence | 51.2% (149/291) | 47.4% (156/329) | 0.86 (0.63–1.18) | 0.90 (0.64–1.28) |
| Fecal incontinence | 12.3% (36/292) | 12.8% (42/329) | 1.04 (0.65–1.68) | 0.95 (0.55–1.63) |
| **Number of pelvic floor disorder** | | | | |
| 0 | 40.4% (114/282) | 41.7% (134/321) | 1.06 (0.76–1.46) | 1.06 (0.74–1.51) |
| 1 | 42.6% (120/282) | 41.7% (134/321) | 0.97 (0.70–1.34) | 1.04 (0.73–1.48) |
| 2 | 14.9% (42/282) | 14.3% (46/321) | 0.96 (0.61–1.50) | 0.87 (0.53–1.43) |
| 3 | 2.1% (6/282) | 2.2% (7/321) | 1.03 (0.34–3.09) | 0.74 (0.22–2.46) |

sion analysis. Smoking (aOR 2.10, 95% CI 1.35–3.26) and perineal tears grade 3–4 (aOR 2.62, 95% CI 1.27–5.42) remained statistically significant risk factors for FI after multivariable logistic regression.

## Discussion

### Main findings

Caesarean delivery was associated with a significant risk reduction for sPOP (aOR = 0.42) and UI (aOR = 0.65) when compared with normal vaginal delivery. Operative vaginal delivery was associated with increased risk of sPOP (aOR = 1.73) and FI (aOR = 1.96) when compared with normal vaginal delivery. There were no significant differences between forceps and vacuum deliveries for any of the main outcome variables.

### Strengths and limitations

The study population was large and data were collected from three different sources (questionnaires, the Norwegian Medical Birth Registry and the Hospital Patient Administrative System).

The present study is the hitherto largest epidemiological study addressing possible risk difference between forceps and vacuum deliveries regarding pelvic floor dysfunction. Since the prevalence of sPOP, UI and FI increases with age, one strength of this study was that women were followed up 15–23 years after their first delivery.

Doctors at Trondheim University Hospital performed FD and VD with a similar frequency (3–5% of all deliveries) between 1990 and 1997, and doctors were well trained in both methods during this period. Thus the comparison between FD and VD was done in a setting where any pelvic floor trauma most likely was a consequence of the delivery method.

Rotational forceps was not recommended at Trondheim University Hospital during 1990–97, and FD was only carried out for low or mid-cavity fetal head in occiput anterior or occiput posterior position. VD was allowed if the fetal head was at or below the spine and for all head positions. Higher stations and different positions may implicate higher risk of trauma and may have introduced bias against VD. Another possible source of bias was better training and/or operative skills for FD. In 1980–89 the FD:VD ratio was 3:1 at Trondheim University Hospital, whereas in 2000–2010 the FD:VD ratio was 1:8. Over a period of 15–20 years VD became the method of choice for OVD in this hospital. Theoretically doctors were better trained in FD than VD during 1990–97. Thus, both these possible biases would be towards more complications in the VD group.

The CD rate among primiparous women was stable (11–14%) between 1990–97. Episiotomy was performed as a routine for OVD, and episiotomy rates were 73–82% between 1995 and 1997, with no reliable data prior to 1995. Thus, correction for episiotomy as a potential confounder was not possible.

The response rate of 53% is considered acceptable for this type of study but may influence the generalisability of the results. It is known that symptomatic women are more prone to participate in studies[23] and it is therefore possible that the prevalence of symptoms was overestimated in the study population. Women in the study were predominantly white European, and the results should be interpreted with caution for diverse ethnic groups.[20,22,23] Since the response rate was similar in the four delivery groups, we contend that a comparison between groups is valid.

No distinction was made between elective and acute CD because the subgroups were too small. Other authors have shown no difference between acute and elective CD for PFD.[18,19,22]

A validated translation to Norwegian of questionnaires on pelvic organ prolapse, urinary and fecal incontinence was not available when the study was conducted. We chose a translation of the PFDI-20 used by other Norwegian investigators which has not yet been published. PFDI-20 is not a screening questionnaire, but for the analyses we extracted five clearly formulated key questions and counted any positive response without calculation of scale scores. Counting any positive response as diagnostic for PFD without regard to severity of symptoms, may have contributed to the relatively high prevalence of PFD in our study population.

A weakness of this study is that a cross-sectional study design may prove an association between delivery mode and prevalence of PFD, but not causality between the two.

### Interpretation

Our results support previous studies reporting that CD is associated with lower prevalence of PFD and OVD is associated with higher prevalence of PFD. This may be due to a relative fetal maternal disproportion causing the need for OVD, or due to the mechanical effect of the forceps and vacuum devices on the pelvic floor connective tissue, muscles and nerves.

We found no statistically significant association between sPOP, UI or FI and mode of operative vaginal delivery (FD and VD). Since the confidence intervals in our study were large, we are unable to rule out a clinically relevant difference in favour of either FD or VD. Our findings contrast with the results from a smaller study demonstrating that FD, and not VD, increased the odds of PFD compared with NVD 5–10 years after delivery[26] and a randomised study demonstrating higher prevalence of FI after FD compared with VD.[27] A long-term follow-up of women may provide additional information, because the prevalence of symptoms and performed surgery will increase with advancing age.

There are several risk factors, which may act as confounding variables in the analysis of a possible association between mode of delivery and PFD. Studies have demonstrated a strong effect of parity on the prevalence of sPOP, UI and FI.[11–13,15,21,22] We found an association between sPOP and increasing parity, but this was not statistically significant. However, a statistically significant association between parity and UI was found in the present study. Large babies (increasing birthweight) only influenced the prevalence of UI in the present study, but other authors have demonstrated that high birthweight is a risk factor for sPOP and FI.[17,18,31] Obesity is an established risk factor for sPOP and UI.[11,12,17,18,24] We found a non-significant association between sPOP and increasing BMI and a significant association between increasing BMI and UI. Both obesity and coughing increase intra-abdominal pressure and the mechanical load on the pelvic floor. Coughing more than doubled the odds for sPOP in our study. An effect of smoking on FI has been found previously[25] and also in our study. Cigarette smoking may directly influence gastrointestinal motility, but may also be linked to other confounding factors such as educational level, physical activity, and alcohol consumption. A protective effect of mediolateral episiotomy on FI has been suggested in previous studies,[17,31] whereas others have demonstrated an association between high rates of routine episiotomy and anal incontinence.[32] Women with OVD in our study had a high rate of episiotomy, but meaningful analysis of this was not possible due to unreliable data. Perineal tear grade 3–4 was the risk factor with the strongest association with FI in our study, which is in concordance with previous studies.[3,17,31]

## Conclusion

Caesarean delivery is associated with decreased risk and operative vaginal delivery with increased risk of pelvic floor dysfunction when compared with normal vaginal delivery. We found no statistically significant difference between forceps and vacuum deliveries. Further long-term follow-up studies will be needed to determine any clinically relevant differences in pelvic floor dysfunction after forceps or vacuum deliveries, and thereby advise on the method of choice during operative vaginal delivery.

### Disclosure of interests

We declare no conflict of interest.

### Contribution to authorship

IV and KÅS were involved in the conception and design of the study and acquisition of data. IV, KÅS, SM and ØS were involved in analysis and interpretation of data. IV and KÅS drafted the article and all authors were involved in critical revision of the manuscript. All authors approved the final version of the article.

### Details of ethics approval

Ethical approval of the study was obtained from the Regional Committee for Medical and Health Research Ethics 23 March 2012, ref no.: REK midt 2012/666.

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## Supporting Information

Additional Supporting Information may be found in the online version of this article:

**Table S1.** Possible confounder's contribution to outcome variables. ■

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