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Prevalence and predictors of anal incontinence during pregnancy and 1 year after delivery: a prospective cohort study

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Objective To evaluate the prevalence and predictors of anal incontinence (AI) in late pregnancy and 1 year after delivery.

Design Prospective population-based cohort study.

Setting Two maternity units in Norway 2009–2010.

Population Primiparae aged 18 years or over.

Methods Primiparae answered questions on the St. Mark's score about AI during the last 4 weeks of pregnancy. One year later, the same questionnaires were distributed by postal mail. Socio-economic and delivery-related data were obtained from hospital records.

Main outcome measures Self-reported AI.

Results Answers on AI in late pregnancy were obtained from 1571 women, and 1030 responded 1 year later. Twenty-four per cent experienced one and 4.7% experienced three or more AI symptoms in late pregnancy. One year later, this was reduced to 19% and 2.2%, respectively. Multivariate logistic regression analyses were applied. Formed and loose stool incontinence were strongly associated at both time points. The main predictor of AI 1 year after delivery was AI in late pregnancy. Obstetric anal sphincter injury increased the risk of incontinence of stool and flatus (odds ratio [OR], 4.1; 95% confidence interval [CI], 1.7–9.6) after delivery. Urgency was associated with greater age (OR, 1.8; 95% CI, 1.0–3.3) and operative delivery (OR, 2.0; 95% CI, 1.3–2.9).

Conclusion One in four primiparae experienced AI in late pregnancy. One year later, still one in five suffered from incontinence. Sphincter injury predicted incontinence of stool and flatus, whereas greater age and operative delivery predicted urgency. The identification and adequate follow-up of pregnant women with AI may reduce AI after delivery.

Keywords Anal incontinence, *post partum*, predictors, pregnancy, prevalence.

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Introduction

Maintaining continence involves a complex mechanism of anorectal function, colonic transit, stool consistency and volume.[1] The International Continence Society defines anal incontinence (AI) as 'involuntary loss of flatus, liquid or solid stool that is a social or hygienic problem'.[2] AI is reported to affect 20% of women over the age of 30 years and urgency has been found to be the variable most strongly associated with AI.[3] The inability to defer defecation for longer than 15 minutes is included in one of the most commonly used AI scoring systems, the St. Mark's score.[4]

During pregnancy, it is suggested that normal hormonal changes, in combination with the pressure from the increasing weight of the fetus, as well as the placenta and uterus, may have a long-term impact on the neuromuscular function of the pelvic floor muscles.[1,5] It is also suggested

that, with regard to incontinence problems in the postpartum period, the changes occurring to anorectal function during pregnancy may be of greater importance than changes occurring during delivery.[6,7] The reported prevalence of AI during pregnancy and *post partum* varies markedly in the literature depending on the definitions of AI/faecal incontinence (FI), the measuring tool used and the time at which the questions regarding incontinence symptoms are asked.[8] In a study by van Brummen et al.,[7] 3% reported FI in late pregnancy and 1 year after delivery, and 42% reported flatus incontinence in late pregnancy and 30% 1 year after delivery. Similarly, King et al.[1] found that 65 and 14% of nulliparous women reported AI and FI, respectively, in the third trimester. Six months after delivery, the corresponding prevalence rates were reduced to 49 and 11%, respectively.

Bols et al.[9] concluded that Obstetric Anal Sphincter Injury (OASI) grade 3 or 4 was the only predictor strongly and moderately associated with FI and flatus incontinence, respectively. In contrast, other studies have found incontinence during pregnancy, age over 35 years at first delivery, obesity and forceps delivery to be independently associated with FI or flatus incontinence.[8,10–12]

The prevalence of AI during pregnancy and *post partum* remains unclear. The importance of pre-existing as opposed to delivery-related risk factors is also uncertain. The aims of this study were to evaluate the prevalence and predictors of the specific symptoms of AI, including urgency, in late pregnancy and 1 year after delivery.

Methods and materials

A pilot study was undertaken between May and September 2009 and the prospective cohort study was undertaken between September 2009 and December 2010. Norwegian-speaking primiparae over the age of 18 years, giving birth to healthy infants in two large hospitals in separate health regions in Norway, were invited to participate before discharge home after delivery. The participants were recruited consecutively. Both hospitals offered high- and low-risk perinatal services. Shortly after delivery, all primiparae in both hospitals were contacted by a physiotherapist and asked to complete a self-reporting questionnaire concerning the symptoms of AI experienced during the last 4 weeks of pregnancy. Completed questionnaires were returned in designated mail boxes at the maternity wards. Women who did not return the questionnaires before discharge received a reminding postal questionnaire to be returned in mailed pre-stamped return envelopes. Non-responders received postal reminders after 4 weeks. One year after delivery, the participants received a postal questionnaire with mailed pre-stamped return envelopes. Demographic data, such as the mother's age, body mass index (BMI) before and at the end of pregnancy, education level and obstetric data, were collected from an electronic obstetric database or hospital obstetrical records.

St. Mark's score

There are a number of different scoring systems used for the assessment of the frequency and severity of AI. The Wexner score and the St. Mark's score are similar; however, the former does not include urgency, nor is it restricted to the reporting of symptoms in the last 4 weeks.[11] In this study, the St. Mark's score was chosen as it measures the frequency of symptoms of AI during the last 4 weeks on a five-point scale (never, rarely, sometimes, weekly and daily). It also includes two questions with dichotomous scales regarding the use of pads, constipating medicine (no, 0 points; yes, 2 points) and the ability to defer defecation for 15 minutes (no, 4 points; yes, 0 points). The total St. Mark's score ranges from complete continence (0 points) to complete incontinence (24 points).[4] AI was defined as having leakage of formed or loose stool monthly or more, leakage of flatus weekly or more, or the inability to defer defecation for more than 15 minutes.

Statistics

Prevalence was calculated with 95% confidence intervals (95% CI). An imputation procedure of the mean score value was used to replace missing values in items of completed questionnaires. The independent samples *t*-test was used when comparing means of continuous variables at baseline. Student's *t*-test for paired data was used when comparing means of continuous variables recorded in late pregnancy and 1 year after delivery. The chi-squared test was used when comparing two categorical variables recorded at the same time point, and the McNemar test was used when comparing repeated categorical variables. The variables describing the symptoms of AI were categorised into continent or incontinent according to the definitions of AI used in this study. A significance level of 5% was chosen. The relationship between the AI symptoms as dependent variables and the various independent aetiological variables, such as age, BMI at delivery and mode of delivery, were assessed using the chi-squared test. Variables found to be significantly related to an AI symptom were included in the univariate regression analyses with the AI symptom as the independent variable. Variables found to be significant in the univariate analyses were included in the multivariate logistic regression model. Multivariate logistic regression analyses were performed to evaluate the independent strength of association between the risk factors for AI. None of the variables in the multivariate logistic regression model were highly correlated.[13] All statistical

analyses were performed using SPSS for Windows version 18 (SPSS Inc., Chicago, IL, USA).

Ethics

Participants received written and/or verbal information, and written consent was obtained prior to inclusion in the study according to the Declaration of Helsinki. The study was registered at clinicaltrials.gov (NCT00970320), and was approved by the Norwegian Regional Committees for Medical and Health Research Ethics (REC Central, No (6) 2008.1318) and the Norwegian Social Science Data Services (NSD).

Results

Fifteen hundred and seventy-one primiparae with a mean age of 28.2 years (standard deviation [SD], 4.7 years) reported their anal function in late pregnancy. One year after delivery, 1031 (66%) responded. In the recruitment period, there were 3442 deliveries by primiparous women at the two hospital sites, resulting in a response rate of 46% among the total number of primiparae. Between 5 and 10% of these women were not eligible for participation because of factors such as inadequate knowledge of the Norwegian language, age under 18 years at delivery or women giving birth to extremely premature infants or infants requiring admission to the paediatric intensive care unit, resulting in an overall response rate of 48–50% (Figure 1). The majority of participants were married or living with their partner (94.1%) at the time of their first delivery. More than 60% had received higher education, 80% were employed full or part time at the start of pregnancy, and few women reported smoking during pregnancy

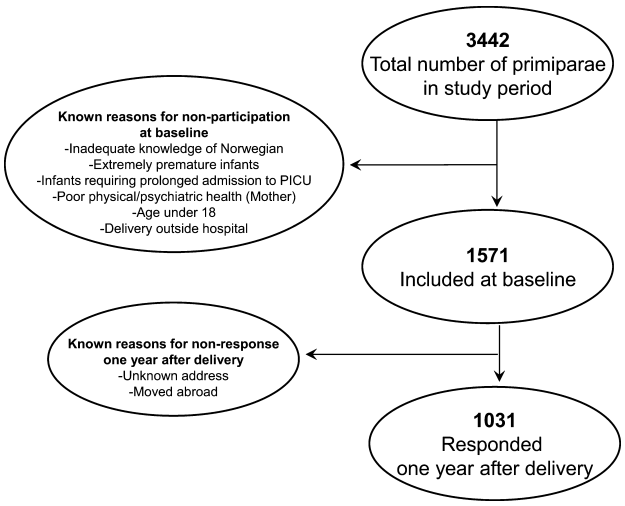

Figure 1. Flow chart of study population. PICU, paediatric intensive care unit.

(Table 1). The participants who answered questions about their anal function both in late pregnancy and 1 year after delivery differed significantly from those who only answered questions related to the last 4 weeks of pregnancy with regard to age, smoking habits, marital status, work status and educational level. We found no significant differences with regard to delivery-related variables between the responders at both time points and non-responders at 1 year after delivery (Table 1).

During the last 4 weeks of pregnancy, one in five reported being unable to defer defecation for more than 15 minutes. Nine per cent and 13% experienced one or more episodes of incontinence of formed stool or loose stool per month, respectively. Flatus incontinence was reported by 12% and the mean St. Mark's score among the women suffering from AI was 6.0 points. The mean St. Marks's score and the occurrence of all symptoms of AI were reduced significantly from late pregnancy to 1 year after delivery, yet urgency remained high, with one in six women reporting urgency (Table 2).

Combination of symptoms

During late pregnancy, 24% of women reported one symptom, 8% reported two symptoms and 4% reported experiencing three symptoms. One year later, the corresponding figures were 19, 5 and 2%, respectively. Four symptoms of AI occurred in <1% of women, either whilst pregnant or after delivery. Thus, any AI was reported by 37% of women in late pregnancy, compared with 26% 1 year after delivery (Table 3).

In late pregnancy, all symptoms of AI were significantly related to each other. The association between formed and loose stool incontinence was found to be particularly large (odds ratio [OR], 36; 95% CI, 24–55). Loose stool incontinence indicated a more than three-fold increase in odds of flatus, and vice versa. The association between urgency and flatus incontinence was found to be significant, although somewhat low, increasing the odds by 70% only (OR, 1.7; 95% CI, 1.2–2.3) (Table 4A).

One year after delivery, the significant association between formed and loose stool incontinence remained very strong (OR, 52; 95% CI, 25–107). Flatus incontinence carried an eight to nine times increased risk of formed or loose stool incontinence, respectively, and formed stool incontinence was associated with an eight-fold increase in urgency. The association between flatus incontinence and urgency was not statistically significant (Table 4B).

Formed stool incontinence

In late pregnancy, the factors associated with an increased risk of formed stool incontinence were unemployment (OR, 2.5; 95% CI, 1.3–4.8) and women aged 22.3 years or

Table 1. Demographic and delivery-related characteristics for participants responding at both time points (late pregnancy [Q1] and 1 year after delivery [Q2]) and participants responding in late pregnancy (Q1) only (non-responders at Q2)

	All participants (n = 1571)	Responders at both Q1 and Q2 (n = 1031)	Responders at Q1 only, non-responders at Q2 (n = 540)	*P*	Birth registry of Norway 2010
Maternal age (years), mean (SD)	28.2 (4.7)	28.9 (4.5)	27.1 (4.8)	<0.001*	27.6 (5.2)
18–27 years	765 (48.7)	450 (43.6)	315 (58.3)		
28–34 years	673 (42.8)	481 (46.7)	192 (35.6)		
35 years or older	133 (8.5)	100 (9.7)	33 (6.1)		
BMI first trimester (kg/m²), mean (SD)	22.9 (6.9)	23.0 (6.9)	22.6 (7.0)	0.231*	NA
Underweight (BMI < 18.4)	51 (3.2)	29 (2.8)	22 (4.1)		
Normal (BMI = 18.4–24.9)	910 (57.9)	603 (58.5)	307 (56.9)		
Overweight (BMI = 25.0–29.9)	279 (17.8)	186 (18.0)	93 (17.2)		
Obese class I (BMI = 30.0–34.9)	105 (6.7)	65 (6.3)	40 (7.4)		
Obese class II & III (BMI > 35.0)	46 (2.9)	36 (3.5)	10 (1.9)		
Missing	180 (11.5)	112 (10.9)	68 (12.6)		
BMI third trimester (kg/m²), mean (SD)	26.1 (10.2)	26.0 (10.1)	26.3 (10.4)	0.531*	NA
Normal (BMI = 18.4–24.9)	222 (14.1)	153 (14.8)	69 (12.8)		
Overweight (BMI = 25.0–29.9)	592 (37.7)	400 (38.8)	192 (35.6)		
Obese class I (BMI = 30.0–34.9)	330 (21.0)	208 (20.2)	112 (22.6)		
Obese class II & III (BMI > 35.0)	161 (10.2)	98 (9.5)	63 (11.7)		
Missing	266 (16.9)	172 (16.7)	94 (17.4)		
Gestation (days), mean (SD)	280 (11.7)	281 (11.5)	280 (12.0)	0.599*	275**** (2.0)
Birthweight (g), mean (SD)	3449 (518)	3462 (51.2)	3422 (52.7)	0.143*	3484**** (605)
Head circumference (cm), mean (SD)	34.9 (1.7)	35.0 (1.7)	34.9 (1.8)	0.274*	NA
Marital status					
Married/cohabiting	1479 (94.2)	986 (95.6)	493 (91.3)	0.001**	56804**** (92.3)
Single, divorced, widowed	88 (5.5)	43 (4.2)	45 (8.3)		4476**** (7.3)
Unknown	4 (0.3)	2 (0.2)	2 (0.4)		260**** (0.4)
Educational level					
Primary	59 (3.8)	27 (2.6)	32 (5.9)	<0.001**	NA
Secondary	496 (31.6)	266 (25.8)	230 (42.6)		
Higher education	957 (60.9)	703 (68.2)	254 (47.0)		
Unknown	59 (3.8)	35 (3.4)	24 (4.4)		
Work status at start of pregnancy					
Employed (full or part time)	1286 (81.9)	872 (84.6)	414 (76.7)	<0.001**	NA
Unemployed	86 (5.5)	38 (3.7)	48 (8.9)		
Missing	199 (12.7)	121 (11.7)	78 (14.4)		
Smoking					
Non-smoking	1221 (77.7)	852 (82.6)	369 (68.3)		44591/61540**** (72.5)
Smoking first trimester	145 (9.2)	64 (6.2)	81 (15.0)	<0.001**	8040/61540**** (13.1)
Missing	13 (0.8)	6 (0.6)	7 (7.3)		8909/61540**** (14.5)

Table 1. (Continued)

	All participants (n = 1571)	Responders at both Q1 and Q2 (n = 1031)	Responders at Q1 only, non-responders at Q2 (n = 540)	P	Birth registry of Norway 2010
Smoking third trimester	50 (3.2)	22 (2.1)	28 (5.2)	0.001**	3368/61540**** (0.5)
Missing	142 (9.0)	86 (8.3)	56 (10.4)		8909/61540**** (14.5)
Mode of delivery					
Vaginal delivery	1338 (85.2)	882 (85.5)	456 (84.4)	0.803**	51876/62591**** (82.9)
Breech presentation	55	34	21		NA
Vacuum extraction	253	169	84		5157
Forceps delivery	19	12	7		1939
Caesarean delivery	233 (14.8)	149 (14.5)	84 (15.4)		10715/62591**** (17.1)
Elective	48	25	23		4111
Acute	185	124	61		6006
Perineal tear after delivery					
No tear	986 (62.7)	635 (61.6)	351 (65)	0.263**	NA
1st degree	269 (17.1)	187 (18.1)	82 (15.2)		NA
2nd degree	252 (16.0)	164 (15.9)	88 (16.3)		NA
3rd degree	58 (3.7)	42 (4.1)	16 (3.0)	0.425***	1161/61540**** (1.9)
4th degree	6 (0.4)	3 (0.3)	3 (0.6)		
Epidural	545 (34.7)	355 (34.4)	190 (35.2)	0.838**	NA
Missing	49 (3.1)	35 (3.4)	14 (2.6)		
Episiotomy	356 (22.7)	242 (23.5)	114 (21.1)	0.427**	9872/62591****
Missing	12 (1)	6 (0.6)	6 (1.1)		
Presentation					
Occiput anterior	1387 (88.3)	904 (87.7)	483 (49.4)	0.332**	NA
Occiput posterior	105 (6.7)	76 (7.4)	29 (5.4)		
Breech/other	75 (4.8)	48 (4.7)	27 (5.0)		
Missing	4 (0.3)	3 (0.3)	1 (0.2)		

When not specified as mean (SD), number of women (%) are presented. BMI, body mass index; NA, not applicable.
*Independent sample t-test.
**Mann–Whitney U-test.
***Mann–Whitney U-test for difference in prevalence of Obstetric Anal Sphincter Injury (OASI) versus no OASI.
****Including both primiparae and multiparae.

Table 2. Prevalence and comparison of anal incontinence in late pregnancy (Q1) and 1 year after delivery (Q2)

	Late pregnancy (n = 1571)							One year after delivery (n = 1031)		
	All participants (n = 1571)		Responders at both Q1 and Q2 (n = 1031)		Responders at Q1, but not at Q2 (n = 540)			Responders at both Q1 and Q2 (n = 1031)		
	n (%)	95% CI	n (%)	95% CI	n (%)	95% CI	P*	n (%)	95% CI	P
Formed stool once monthly or more	141 (9.0)	(7.5–10.4)	76 (7.4)	(5.8–9.0)	66 (12.2)	(9.4–15.0)	0.001	46 (4.5)	(3.2–5.8)	0.001**
Loose stool once monthly or more	209 (13.3)	(11.6–15.0)	120 (11.6)	(9.7–13.7)	89 (16.5)	(13.3–19.6)	0.002	92 (8.9)	(7.2–10.6)	0.028**
Flatus weekly or more	185 (11.8)	(10.2–13.5)	123 (11.9)	(10.0–14.0)	63 (11.7)	(8.9–14.6)	0.326	60 (5.8)	(4.5–7.4)	<0.001**
Urgency (15 minutes)	321 (20.4)	(18.4–22.6)	196 (19.0)	(16.8–21.6)	125 (23.1)	(19.5–26.7)	0.055	166 (16.1)	(13.9–18.3)	0.049**
St. Mark's score among women with anal incontinence, mean [range]	6.0 [1–18]	(5.5–6.5)	5.3 [1–18]	(5.0–5.6)	6.1 [1–16]	(5.6–6.6)	<0.001	5.1 [1–15]	(4.8–5.5)	0.002***

*Independent samples t-test: responders at both Q1 and Q2 versus responders at Q1, but not Q2.
**McNemar test: results all responders at Q1 (late pregnancy) versus responders at both Q1 and Q2 (1 year after delivery).
***Paired samples t-test: results all responders at Q1 (late pregnancy) versus responders at both Q1 and Q2 (1 year after delivery).

under (10th percentile) (OR, 2.4; 95% CI, 1.2–5.0) (Table 5). Women who experienced formed stool incontinence in late pregnancy (OR, 13.3; 95% CI, 6.8–25) and women who had sustained an OASI grade 3 or 4 (OR, 3.7; 95% CI, 1.3–10.8) were at a significantly increased risk of formed stool incontinence after delivery.

Loose stool incontinence

In late pregnancy, women with high education levels were less likely to develop loose stool incontinence (OR, 0.59; 95% CI, 0.4–0.9), and unemployed (OR, 2.0; 95% CI, 1.2–3.5) and younger aged (OR, 1.8; 95% CI, 1.0–3.0) women were more likely to suffer from incontinence of loose stool. One year after delivery, women having loose stool incontinence in late pregnancy (OR, 3.0; 95% CI, 1.5–5.9), women aged 22 years or younger (OR, 4.2; 95% CI, 1.5–12) and women with a BMI of 35 or more in late pregnancy (OR, 2.8; 95% CI, 1.4–5.6) had an increased risk of loose stool incontinence (Table 5).

Flatus incontinence

In late pregnancy, being unemployed was the only factor significantly associated with an increased risk of suffering from flatus incontinence more than once weekly. Delivering a baby with a head circumference of more than 37 cm significantly reduced the risk of flatus incontinence (OR, 0.28; 95% CI, 0.1–0.8), whereas having flatus incontinence in late pregnancy (OR, 4.2; 95% CI, 2.3–7.5) or sustaining an OASI grade 3 or 4 at delivery (OR, 4.1; 95% CI, 1.7–9.6) increased the risk of flatus incontinence 1 year after delivery (Table 5).

Urgency

In late pregnancy, having a high education level was associated with a decrease in the risk of experiencing problems with deferring defecation for 15 minutes (OR, 0.7; 95% CI, 0.5–0.97). Unemployment increased the odds of urgency by 70% (OR, 1.7; 95% CI, 1.0–2.9) (Table 5).

One year after delivery, there was a two-fold increase in the odds of experiencing urgency among women with vacuum- or forceps-assisted deliveries, unemployment and women aged over 34.2 years (90th percentile) at delivery. Experiencing urgency in late pregnancy increased the risk five times (OR, 5.0; 95% CI, 3.3–7.6) (Table 5).

All results from the univariate and multivariate models of the regression analyses are presented in Supporting Information Table S1.

Discussion

In this prospective cohort study, we found that the prevalence of AI among primiparae was reduced significantly from late pregnancy to 1 year after delivery. Higher

Table 3. Prevalence of anal incontinence by combination of symptoms

Symptoms of anal incontinence	Late pregnancy All participants (n = 1571)		One year after delivery Responders at both Q1 and Q2 (n =1031)	
Formed stool only	17		8	
Loose stool only	55		30	
Flatus only	92		31	
Urgency only	212		130	
Percentage with one symptom		23.9		19.3
Formed + loose	47		17	
Formed + flatus	5		2	
Formed + urgency	11		1	
Loose + flatus	16		9	
Loose + urgency	21		14	
Flatus + urgency	23		3	
Percentage with two symptoms		7.8		4.6
Formed + loose + flatus	20		4	
Formed + loose + urgency	24		7	
Formed + flatus + urgency	4		0	
Loose + flatus + urgency	12		4	
Percentage with three symptoms		3.8		1.5
Formed + loose + flatus + urgency	14		7	
Percentage with four symptoms		0.9		0.7
Total	573	36.5%	267	25.9%

Table 4. The association (A) between the different symptoms of anal incontinence in late pregnancy, univariate logistic regression analyses and (B) between the symptoms of anal incontinence 1 year after delivery, univariate logistic regression analyses

	Formed stool OR (95% CI)	Loose stool OR (95% CI)	Flatus OR (95% CI)	Urgency OR (95% CI)
(A)				
Formed stool		36.2 (23.6–55.2)*	3.9 (2.6–5.8)*	2.6 (1.8–3-7)*
Loose stool			4.2 (3.0–6.0)*	2.3 (1.7–3.1)*
Flatus				1.7 (1.2–2.3)**
Urgency				
(B)				
Formed stool		51.8 (25.0–107.3)*	7.9 (3.9–15.9)*	7.9 (3.9–15.9)**
Loose stool			8.9 (5.0–15.7)*	3.2 (2.0–5.1)*
Flatus				1.6 (0.9–3.1)
Urgency				

*$P < 0.001$.
**$P < 0.005$.

education reduced the risk of AI in late pregnancy, and experiencing symptoms of AI in pregnancy markedly increased the risk of postpartum AI, although the risk factors appeared to be different for stool and flatus incontinence relative to urgency in both late pregnancy and 1 year after delivery. OASI was associated with stool and flatus incontinence, whereas instrumental delivery was associated with urgency.

Compared with similar studies, the present study is relatively large and has a prospective cohort design, enabling an assessment of pre-existing and delivery-related factors affecting the prevalence of AI 1 year after delivery.[6,7,10,12,14] The validity of the present findings is also supported by the reproducibility, correlation with other clinical assessment tools and the sensitivity to change of the St. Mark's incontinence score.[4,15] Accord-

Table 5. Predictors of anal incontinence in late pregnancy and 1 year after delivery, logistic multivariable regression analyses

	Late pregnancy (n = 1571)*		One year after delivery (n = 1031) **	
	OR (95% CI)	***P***	**OR (95% CI)**	***P***
Formed stool incontinence (dependent variable)				
Age <22.3 years vs >22.3 years	2.4 (1.2–5.0)	**0.014**	2.0 (0.8–5.1)	0.126
High level vs primary/secondary education	0.7 (0.4–1.3)	0.252	NS	
Unemployed vs employed	2.5 (1.3-4.8)	**0.004**	NS	
Daily smoking first trimester vs non-smoking	NS	NS	NS	
Daily smoking third trimester vs non-smoking	1.0 (0.4–2.9)	0.988	NS	
Grade 3 or 4 vs no sphincter injury	NA		3.7 (1.3–10.8)	**0.015**
Caesarean section vs vaginal delivery	NA		NS	
Occiput posterior vs occiput anterior position	NA		NS	
Episiotomy vs no episiotomy	NA		NS	
Epidural vs no epidural	NA		NS	
Formed stool incontinence vs no formed stool incontinence in late pregnancy	NA		13.3 (6.8–25.9)	**<0.001**
Loose stool incontinence (dependent variable)				
Age <22.3 years vs >22.3 years	1.8 (1.0–3.0)	**0.034**	4.2 (1.5–12.1)	**0.008**
High vs primary/secondary education	0.59 (0.4–0.9)	**0.005**	1.1 (0.6–2.3)	0.756
Unemployed vs employed	2.0 (1.2–3.5)	**0.013**	1.9 (0.7–5.5)	0.230
BMI late pregnancy >35 vs <35			2.8 (1.4–5.6)	**0.004**
Smoking during first trimester vs non-smoking	1.2 (0.7–2.1)	0.499	NS	
Gestational age >282 days vs <282 days	NA		1.6 (0.9–2.8)	0.145
Grade 3 or 4 vs no sphincter injury	NA		3.4 (1.3–8.9)	**0.013**
Caesarean section vs vaginal delivery	NA		NS	
Occiput posterior vs occiput anterior position	NA		NS	
Episiotomy vs no episiotomy	NA		NS	
Epidural vs no epidural	NA		NS	
Loose stool incontinence vs no loose stool incontinence in late pregnancy	NA		3.0 (1.5–5.9)	**0.002**
Flatus incontinence (dependent variable)				
Unemployed vs employed	1.9 (1.1–3.3)	**0.032**	NS	
Head circumference >37 cm vs <37 cm	NA		0.3 (0.1–0.8)	**0.019**
Grade 3 or 4 vs no sphincter injury	NA		4.1 (1.7–9.6)	**0.001**
Caesarean section vs vaginal delivery	NA		NS	
Occiput posterior vs occiput anterior position	NA		NS	
Episiotomy vs no episiotomy	NA		NS	
Epidural vs no epidural	NA		NS	
Flatal incontinence vs no flatus incontinence in late pregnancy	NA		4.2 (2.3–7.5)	**<0.001**
Urgency (dependent variable)				
Age >34.2 years vs <34.2 years	NS		1.8 (1.0–3.3)	**0.045**
High vs primary/secondary education	0.7 (0.5–0.97)	**0.032**	NS	

Table 5. (Continued)

	Late pregnancy (n = 1571)*		One year after delivery (n = 1031) **	
	OR (95% CI)	P	OR (95% CI)	P
Unemployed vs employed	1.7 (1.0–2.9)	**0.045**	2.5 (1.1–5.7)	**0.026**
BMI late pregnancy >35 vs <35	1.4 (0.9–2.1)	0.127	NS	
Vacuum- or forceps-assisted vs spontaneous vaginal delivery	NA		2.0 (1.3–2.9)	**0.001**
Caesarean section vs vaginal delivery	NA		NS	
Occiput posterior vs occiput anterior position	NA		NS	
Episiotomy vs no episiotomy	NA		NS	
Epidural vs no epidural	NA		NS	
Urgency vs no urgency in late pregnancy	NA		5.0 (3.3–7.6)	**<0.001**

NA, not applicable; NS, variables not found to be statistically significant in the univariate analysis 1 year after delivery.
Values in bold indicate significant predictors of AI.
*All included variables were found to be statistically significant in the univariate analyses in late pregnancy.
**All included variables were found to be statistically significant in the univariate analyses 1 year after delivery.

ing to Bradford Hill's criteria for causation, some of our findings, such as the association between OASI and incontinence, may be considered bioplausible, coherent and in agreement with previous findings.[16] Further, the strength of some of the associations found, in particular between AI in late pregnancy and 1 year after delivery, indicates a causal pattern. However, the criteria required to make causal inferences are not fully met in this study, as the findings are based on an observational and not a randomised study. The focus is therefore on the associations found to influence the risk of experiencing AI.[17]

The response rate in this study is comparable with that in similar studies at baseline, although somewhat lower at follow-up 1 year after delivery.[7,12,14,18] This may have had an impact on the validity of some of our findings. It has been suggested that, as a result of the sensitive nature, questions regarding AI tend to have low response rates.[8,19] Others have indicated that self-reporting anonymous questionnaires improve response rates and the reporting of sensitive information.[7,20] Considering that few sufferers seek medical care and that health professionals may not readily enquire about AI, our response rate 1 year after delivery was regarded as acceptable.[20–22] However, those who responded at both time points were significantly older and fewer were unemployed compared with those who did not respond 1 year after delivery. As a young age at delivery and unemployment were factors significantly associated with formed and loose stool incontinence in late pregnancy and only loose stool incontinence 1 year after delivery, it is likely that these differences may have resulted in an underestimation of stool incontinence 1 year after delivery and a possible confounding effect. Although some authors have suggested that, overall, respondents are more likely to have incontinence than non-respondents, and that the non-responding cases at follow-up are more likely to have resolved, our findings 1 year after delivery, in particular, must be interpreted with caution.[8,23,24]

The prevalence rates of formed stool, loose stool or flatus incontinence in late pregnancy in this study were lower than those reported previously.[11,14] Although significantly reduced from late pregnancy, the AI rates reported on the St. Mark's score were somewhat higher 1 year after delivery, compared with other studies using less specific questions regarding frequency, different symptoms of AI and specific time period.[1,7,14,25] The discrepancies in the rates of flatus incontinence compared with similar studies may be explained by the more restrictive definition of leakage of flatus weekly or more used in this study. The present definition was based on reports describing flatus incontinence as the most common and least bothersome symptom of AI.[11,14,20,26]

Similar to previous findings, the rate of urgency (problems deferring defecation for 15 minutes) was the AI symptom most commonly reported.[14] Possibly as a result of discrepancies in the definition of urgency, the prevalence of urgency in this study was, however, more than twice as high as among pregnant and postpartum women with problems deferring defecation for 5 minutes.[23] Considering the spontaneous changes occurring to the pelvic floor function during the first 6 months after delivery, it may be that more specific questioning with regard to the frequency of the particular AI symptoms within a defined time period, such as on the St. Mark's score, is better suited to assess the prevalence of AI in the postpartum period relative to less specific scoring systems.[27]

In agreement with previous short- and long-term studies, our findings suggest that experiencing one symptom of AI in late pregnancy is associated with also experiencing the same symptom after delivery.[7,11,28] In particular, the association between formed and loose stool incontinence was found to be large at both time points, as reported previously.[29] Formed and loose stool incontinence were also closely related to urgency. It has been suggested that, in order to avoid episodes of leakage, patients should take precautions, resulting in an increased prevalence of urgency.[3] As the maternity leave period *post partum* in Norway was 33 weeks until 1 July 2011, it is likely that the majority of mothers in this material had returned to work when responding to the questionnaire 1 year after delivery. Assuming that bathrooms may not be as readily available at work as at home, this may, in part, explain why the prevalence of urgency remains relatively high 1 year after delivery. In addition, for women having experienced leakage of stool, frequent visits to the bathroom are likely to be preferable to the embarrassing event of a leakage episode whilst at work.

One year after delivery, the factors predicting AI tended to be delivery related. There has been some debate as to whether the mode of delivery and OASI are related to the subsequent development of AI or are only surrogate markers for other obstetric factors associated with AI.[6,9,28,30,31] We found no association between the risk factors of OASI (age, delivery mode, occiput posterior position, epidural, episiotomy) and the prevalence of AI 1 year after delivery. OASI was significantly associated with stool and flatus incontinence, as shown previously.[5,7,9,14,31] Urgency was significantly associated with instrumental deliveries and higher age, but not OASI, suggesting that incontinence and urgency, to some extent, have different aetiologies. As a result of the small number of cases, neither the potential difference between the impact of a fourth- compared with a third-degree OASI, nor between forceps- and vacuum-assisted deliveries, in the development of postpartum AI could be assessed.[32]

Conclusion

AI is a common problem among primiparae in both late pregnancy and 1 year after delivery. In late pregnancy, higher education showed a protective effect of AI. One year after delivery, experiencing AI in late pregnancy and OASI were predictors of stool and flatus incontinence, whereas urgency in late pregnancy, instrumental delivery, greater age and unemployment predicted urgency. Our findings suggest that the identification of women experiencing AI in late pregnancy may aid in the facilitation of adequate treatment and follow-up in the postpartum period. The fact that one in five women still experiences some incontinence 1 year after delivery, with OASI being a strong predictor of incontinence, supports the ongoing initiative among obstetricians and midwives to prevent unnecessary damage to the pelvic floor during delivery.

Disclosure of interests

There are no conflicts of interest.

Contribution to authorship

All authors contributed to the drafting of the original study protocol. HHJ, AS, AW, SM and LS contributed to the analysis and interpretation of the data. HHJ, AW, BB and LS drafted the paper, and all authors commented on and approved the final version.

Details of ethics approval

Participants received written and/or verbal information, and written consent was obtained prior to inclusion in the study. The study is registered at clinicaltrials.gov (NCT00970320), and was approved by the Norwegian Regional Committees for Medical and Health Research Ethics (REC Central, No (6)2008.1318. Approved 04.07.2008) and the Norwegian Social Science Data Services (NSD).

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Supporting Information

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

Table S1. Predictors of anal incontinence in late pregnancy and 1 year after delivery, logistic regression analyses. ■

References

1 King VG, Boyles SH, Worstell TR, Zia J, Clark AL, Gregory WT. Using the Brink score to predict postpartum anal incontinence. *Am J Obstet Gynecol* 2010;203:486.e1–5.

2 Norton C, Christiansen I, Butler U, Harari D, Nelson R, Pembertonm J, et al. Anal incontinence. In: Abrams P, Cardozo L, Khoury S, Wein A, editors. *Incontinence. International Consultation on Incontinence, 2001*, 2nd edn. Paris: Health Publications, Ltd; 2002. pp. 985–1043.

3 Rommen K, Schei B, Rydning AH, Sultan A, Morkved S. Prevalence of anal incontinence among Norwegian women: a cross-sectional study. *BMJ Open* 2012;2:e001257. doi: 10.1136/bmjopen-2012-001257. Print 2012.

4 Vaizey CJ, Carapeti E, Cahill JA, Kamm MA. Prospective comparison of faecal incontinence grading systems. *Gut* 1999; 44:77–80.

5 MacLennan AH, Taylor AW, Wilson DH, Wilson D. The prevalence of pelvic floor disorders and their relationship to gender, age, parity and mode of delivery. *BJOG* 2000;107:1460–70.

6 Borello-France D, Burgio KL, Richter HE, Zyczynski H, Fitzgerald MP, Whitehead W, et al. Fecal and urinary incontinence in primiparous women. *Obstet Gynecol* 2006;108:863–72.

7 van Brummen HJ, Bruinse HW, van de Pol G, Heintz AP, van der Vaart CH. Defecatory symptoms during and after the first pregnancy: prevalences and associated factors. *Int Urogynecol J Pelvic Floor Dysfunct* 2006;17:224–30.

8 Macarthur C, Wilson D, Herbison P, Lancashire RJ, Hagen S, Toozs-Hobson P, et al. Faecal incontinence persisting after childbirth: a 12 year longitudinal study. *BJOG* 2013;120:169–78; discussion 178–9.

9 Bols EM, Hendriks EJ, Berghmans BC, Baeten CG, Nijhuis JG, de Bie RA. A systematic review of etiological factors for postpartum fecal incontinence. *Acta Obstet Gynecol Scand* 2010;89:302–14.

10 Espuna-Pons M, Solans-Domenech M, Sanchez E, On Behalf of the Pelvic Floor Research Group (Grup de Recerca del Sol Pelvia, GRESP). Double incontinence in a cohort of nulliparous pregnant women. *Neurourol Urodyn* 2012;31:1236–41.

11 Solans-Domenech M, Sanchez E, Espuna-Pons M, Pelvic Floor Research Group (Grup de Recerca del Sol Pelvia, GRESP). Urinary and anal incontinence during pregnancy and postpartum: incidence, severity, and risk factors. *Obstet Gynecol* 2010;115:618–28.

12 Guise JM, Morris C, Osterweil P, Li H, Rosenberg D, Greenlick M. Incidence of fecal incontinence after childbirth. *Obstet Gynecol* 2007;109:281–8.

13 Kirkwood B, Sterne JAC. *Essential Medical Statistics*, 2nd edn. Oxford: Blackwell Science Ltd, 2003.

14 Brown SJ, Gartland D, Donath S, MacArthur C. Fecal incontinence during the first 12 months postpartum: complex causal pathways and implications for clinical practice. *Obstet Gynecol* 2012;119:240–9.

15 Dehli T, Martinussen M, Mevik K, Stordahl A, Sahlin Y, Lindsetmo RO, et al. Translation and validation of the Norwegian version of the fecal incontinence quality-of-life scale. *Scand J Surg* 2011;100:190–5.

16 Laake P, Benestad HB, Olsen BR. *Research Methodology in the Medical and Biological Sciences*, 2nd edn. London: Elsevier Ltd., 2007.

17 Hernan MA, Taubman SL. Does obesity shorten life? The importance of well-defined interventions to answer causal questions. *Int J Obes (Lond)* 2008;32(Suppl 3):S8–14.

18 Faltin DL, Sangalli MR, Roche B, Floris L, Boulvain M, Weil A. Does a second delivery increase the risk of anal incontinence? *BJOG* 2001;108:684–8.

19 MacArthur C, Glazener C, Lancashire R, Herbison P, Wilson D. ProLong study group. Exclusive caesarean section delivery and subsequent urinary and faecal incontinence: a 12-year longitudinal study. *BJOG* 2011;118:1001–7.

20 Boreham MK, Richter HE, Kenton KS, Nager CW, Gregory WT, Aronson MP, et al. Anal incontinence in women presenting for gynecologic care: prevalence, risk factors, and impact upon quality of life. *Am J Obstet Gynecol* 2005;192:1637–42.

21 Backe B, Sahlin Y. Too many obstetrical sphincter ruptures. *Tidsskr Nor Laegeforen* 2005;125:554.

22 Chien PF. Surveying clinical surveys. *BJOG* 2009;116:1285–9.

23 Chaliha C, Sultan AH, Bland JM, Monga AK, Stanton SL. Anal function: effect of pregnancy and delivery. *Am J Obstet Gynecol* 2001;185:427–32.

24 Lo J, Osterweil P, Li H, Mori T, Eden KB, Guise JM. Quality of life in women with postpartum anal incontinence. *Obstet Gynecol* 2010;115:809–14.

25 Brincat C, Lewicky-Gaupp C, Patel D, Sampselle C, Miller J, Delancey JO, et al. Fecal incontinence in pregnancy and post partum. *Int J Gynaecol Obstet* 2009;106:236–8.

26 Altman D, Ekstrom A, Forsgren C, Nordenstam J, Zetterstrom J. Symptoms of anal and urinary incontinence following cesarean section or spontaneous vaginal delivery. *Am J Obstet Gynecol* 2007;197:512.e1–7.

27 Nazir M, Stien R, Carlsen E, Jacobsen AF, Nesheim BI. Early evaluation of bowel symptoms after primary repair of obstetric perineal rupture is misleading: an observational cohort study. *Dis Colon Rectum* 2003;46:1245–50.

28 Nordenstam J, Altman D, Brismar S, Zetterstrom J. Natural progression of anal incontinence after childbirth. *Int Urogynecol J Pelvic Floor Dysfunct* 2009;20:1029–35.

29 Botlero R, Bell RJ, Urquhart DM, Davis SR. Prevalence of fecal incontinence and its relationship with urinary incontinence in women living in the community. *Menopause* 2011;18:685–9.

30 Pretlove SJ, Thompson PJ, Toozs-Hobson PM, Radley S, Khan KS. Does the mode of delivery predispose women to anal incontinence in the first year postpartum? A comparative systematic review *BJOG* 2008;115:421–34.

31 Fenner DE, Genberg B, Brahma P, Marek L, DeLancey JO. Fecal and urinary incontinence after vaginal delivery with anal sphincter disruption in an obstetrics unit in the United States. *Am J Obstet Gynecol* 2003;189:1543–9; discussion 1549–50.

32 Laine K, Skjeldestad FE, Sanda B, Horne H, Spydslaug A, Staff AC. Prevalence and risk factors for anal incontinence after obstetric anal sphincter rupture. *Acta Obstet Gynecol Scand* 2011;90: 319–24.

Commentary on 'Prevalence and predictors of anal incontinence during pregnancy and 1 year after delivery: a prospective cohort study'

A meta-analysis of published reports that assessed anal sphincter integrity after vaginal delivery (VD) and correlated this with anal continence stated that 77–83% (depending on parity) of anal incontinence (AI) in parous women was caused by sphincter disruption (Oberwalder et al., *Br J Surg* 2003;90:1333–37). Three things are implied by this conclusion. First, that those not suffering sphincter disruption as a result of VD, specifically men, children and nulliparous women, or women having caesarean delivery (CD), all being equally exposed to all other risk factors for AI, have a much lower risk of AI than women who have had a VD. There is scant epidemiological evidence that this is the case (Nelson in *Incontinence*, 5th edn. Birmingham, UK: Health Publications Ltd, 2013). Second, it is implied that sphincter repair would be effective treatment for AI in almost all women whose incontinence follows a VD. Yet repair of a disrupted sphincter has less than a perfect track record. Even more importantly, there is a reported rapid decay in function after repair that is far too great to be explained by age alone (Nelson in *Incontinence*, 5th edn. Birmingham, UK: Health Publications Ltd, 2013). Third, if direct trauma to the anal sphincter (and not intrapelvic nerves) were the major cause of AI, CD should be effective in preventing incontinence. A Cochrane review of CD to prevent AI has shown that this is not the case (Nelson et al., *Cochrane Database Syst Rev* 2010;2:CD006756), although randomised trials of CD versus VD in average risk pregnancies are needed to support this conclusion. Adding further evidence that more proximal issues need to be considered in postpartum AI is this excellent study, in which it is found that the strongest predictor of AI 1 year after delivery is AI in the third trimester of pregnancy.

Therefore, strategies for the prevention and treatment of AI must be reconsidered. If pregnancy itself is the culprit, it can hardly be deferred, but early intervention for those women who become symptomatic during pregnancy helps, although it seems that the benefit from pelvic floor exercise is not sustained (Boyle et al., *Cochrane Database Syst Rev* 2012;10:CD007471). Obesity is an independent risk factor for AI and weight loss has been shown to improve symptoms (Nelson in *Incontinence*, 5th edn. Birmingham, UK: Health Publications Ltd, 2013). As the authors state, the reason for younger and less educated women being more prone to intrapartum AI needs to be investigated further.

Disclosure of interests

I have no conflicting interests to declare. ■

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