GYNECOLOGY

Long-term risks of stress and urgency urinary incontinence after different vaginal delivery modes

Riikka M. Tähtinen, MD; Rufus Cartwright, MA, MRCOG, MD(res), PhD; Robin W. M. Vernooij, PhD; Guri Rortveit, MD, PhD; Steinar Hunskaar, MD, PhD; Gordon H. Guyatt, MD; Kari A. O. Tikkinen, MD, PhD

BACKGROUND: Although operative delivery increases the risk of immediate pelvic floor trauma, no previous studies have adequately compared directly the effects of different kinds of instrumental vaginal deliveries on stress urinary incontinence and/or urgency urinary incontinence.

OBJECTIVE(S): The objectives of the study were to estimate and compare the impact of different kinds of vaginal deliveries, including spontaneous, vacuum, and forceps, on stress and urgency urinary incontinence.

STUDY DESIGN: All women aged 20 years or older, living in 1 county in Norway were invited to participate in 2 surveys addressing stress and urgency urinary incontinence using validated questions, "Do you leak urine when you cough, sneeze, laugh, or lift something heavy?" and "Do you have involuntary loss of urine in connection with sudden and strong urge to void?" with response options yes or no. Incontinence data were linked to the Medical Birth Registry of Norway. For this study, we included only women who had a history of vaginal birth(s). Case definitions for stress and urgency urinary incontinence were moderate to severe based on Sandvik Severity Index (slight, moderate, severe). We adjusted analyses for age, parity, body mass index, and time since last delivery and addressed effect modification, including an age threshold of 50 years.

RESULTS: The final analysis included 13,694 women of whom 12.7% reported stress urinary incontinence and 8.4% urgency urinary incontinence. Among women aged younger than 50 years, there was a statistically significant difference in the risk of stress urinary incontinence for forceps delivery (odds ratio, 1.42, 95% confidence interval, 1.09—1.86, absolute difference 5.0%) but not for vacuum (odds ratio, 0.80, 95% confidence interval, 0.59—1.09) when compared with spontaneous vaginal delivery. Among women aged younger than 50 years, forceps also had increased risk for stress urinary incontinence (odds ratio, 1.76, 95% confidence interval, 1.20—2.60) when compared with vacuum. There was no association of stress or urgency urinary incontinence with mode of delivery in women aged 50 years or older.

CONCLUSION: For women aged younger than 50 years, forceps delivery is associated with significant increased long-term risk of stress urinary incontinence compared with other vaginal deliveries.

Key words: forceps, instrumental delivery, stress urinary incontinence, urgency urinary incontinence, urinary incontinence, vacuum, vaginal delivery, ventouse

Urinary incontinence is a common condition among women and is associated with significant impact on quality of life and huge societal costs.[1,2] The International Continence Society and International Urogynecological Association define stress urinary incontinence (SUI) as the involuntary loss of urine on effort or physical exertion or on sneezing or coughing and urgency urinary incontinence (UUI) as involuntary loss of urine associated with a sudden and compelling desire to pass urine.[3]

Both from the population perspective and from an individual perspective, SUI and UUI are the most burdensome and bothersome of all urinary symptoms in women.[4] Established risk factors for both major subtypes of urinary incontinence (UI) include age[2] and body mass index[5]; the prevalence and the associated costs of these conditions is therefore likely to increase with future demographic changes.

Vaginal delivery is associated with an almost 2-fold increase in the risk of developing SUI, compared with cesarean delivery, with a smaller effect on UUI.[6,7] This difference is greatest in younger women and diminishes progressively in older women.[6]

There are, however, no prior studies directly comparing different kinds of operative vaginal deliveries (forceps and vacuum) for the risk of both SUI and UUI. Earlier studies have either analyzed both major subtypes of incontinence as a single cluster or failed to compare vacuum extraction with forceps delivery.

Because SUI and UUI have different underlying pathologies,[2,8] combining them may have obscured important associations. We aimed to estimate and compare the effects of different kinds of vaginal deliveries on SUI and UUI, using a large prospective, population-based study.

Materials and Methods

We used data from the ongoing Nord-Trøndelag Health (HUNT) study. Every citizen of Nord-Trøndelag County in Norway aged 20 years or older was invited to participate in a series of questionnaires, interviews, clinical measurements, and collection of biological samples (blood and urine). The questionnaires included questions on socioeconomic conditions, health-related behaviors, symptoms, illnesses, and diseases.

The present analyses include data from HUNT2 (over the period 1995—1997) and HUNT3 (2006—2008). We obtained ethical approval from the Norwegian Regional Ethics Review

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AJOG at a Glance

Why was this study conducted?

There are no prior studies directly comparing different kinds of operative vaginal deliveries for risk of both stress and urgency urinary incontinence.

Key Findings

For women, aged younger than 50 years, forceps delivery, but not vacuum, is associated with significant increased long-term risk of stress incontinence.

What does this add to what is known?

These data provide an additional rationale for vacuum over forceps when considering long-term incontinence and help decision making between forceps and vacuum.

Board (2016/804/REK nord). All women participating in the surveys gave explicit written consent for the use of the data. We followed the Strengthening the Reporting of Observational Studies in Epidemiology recommendations.[9]

Incontinence questions of the HUNT2 and HUNT3 survey started with an entry question whether the participant experienced involuntary loss of urine (Appendix 1). If the answer was yes, she was asked to answer more specific, validated questions[10]: "Do you leak urine when you cough, sneeze, laugh, or lift something heavy?" and "Do you have involuntary loss of urine in connection with sudden and strong urge to void?" with response options yes or no.

Symptom severity was categorized as slight, moderate, or severe, assessed using the Sandvik Severity Index[10] (Appendix 1). In the current study, we defined women reporting SUI (with or without UUI) and UUI (with or without SUI) with severity of moderate or severe as having the condition.

Body mass index (kilograms per square meter) was calculated from direct measures of height and weight at the HUNT screening station at the time participants completed their surveys. We linked these HUNT2 and HUNT3 information to data from the Medical Birth Registry of Norway,[11] which has registered information on all deliveries in Norway since 1967.

Information on parity and years since last delivery were also obtained from the birth registry. If a woman had participated both HUNT2 and HUNT3, we used survey information from HUNT3 to maximize the time from the last delivery to assessment of urinary incontinence. However, if a participant was excluded from our analyses in HUNT3 (because of a current pregnancy or being in the first postpartum year at the time of the survey), we used the available information from HUNT2.

Based on earlier literature,[6] we hypothesized that increases in both SUI and UUI associated with both forceps and vacuum deliveries would be greater in women younger than 50 years vs those 50 years old or older and tested the hypothesis with a test of interaction. Because we found significant interactions ($P < .01$) consistent with all hypotheses (larger impact with both forceps and vacuum on both SUI and UUI in younger women), we present results separately for women aged younger than 50 years and 50 years old or older.

We adjusted these analyses, presented separately for SUI and UUI, for the following prespecified known risk factors: age,[2] body mass index (BMI; <25, 25−30, ≥30 kg/m^2),[5] parity,[12] and years since last delivery.[12] We also performed a sensitivity analysis that included along with age, parity, BMI, and years since last delivery, adjusting for the weight of the each participant's heaviest baby.

To calculate the absolute risk increase of SUI with forceps delivery, we estimated the absolute risk of patient important/bothersome SUI after spontaneous vaginal delivery using a large population-based study[13]: 12.0% for SUI after spontaneous vaginal delivery among women aged younger than 50 years and then used the odds ratio (OR) to calculate the absolute risk increase with forceps delivery.[14]

We also performed longitudinal analyses including women who delivered during follow-up (except if surveyed during the first postpartum year or during pregnancy at baseline or follow-up). Although of all HUNT2 participants, 72% of women also participated in HUNT3, these analyses were underpowered, with no statistically significant effects of delivery mode on SUI or UUI detectable. Summary data of these analyses are shown in Appendix 2.

Finally, to estimate selection bias, we compared the baseline characteristics of responders and nonresponders. The statistical software package SPSS 24.0 (SPSS Inc, Chicago, IL) was used for all data analyses.

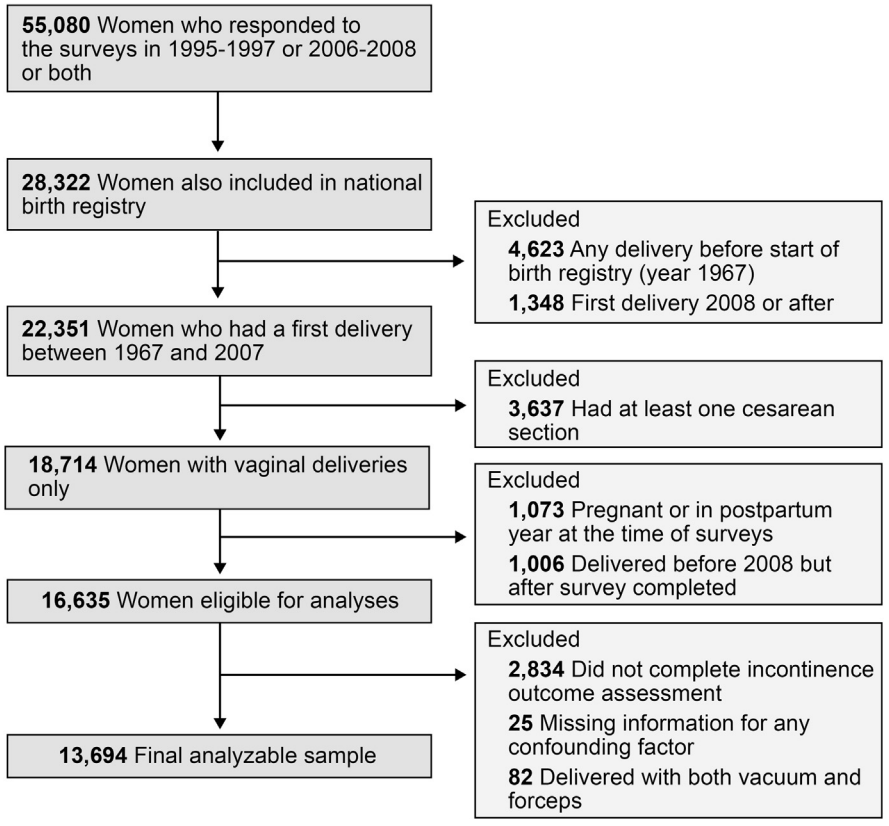
Results

A total of 55,080 women participated either in HUNT2 or HUNT3 or both. Of these, 28,322 women were also included to the Medical Birth Registry of Norway and responded to the surveys. We excluded women who had ever given birth before 1967, had any cesarean delivery, had both vacuum and forceps deliveries, or were nulliparous, pregnant, or in the postpartum year at the time of survey.

The final analyzable sample was 13,694 women (Figure 1). Moderate to severe SUI and UUI were reported by 1745 (12.7%) and 1157 (8.4%) women. Characteristics are summarized in the Table and grouped according to mode of delivery. In comparison of responders (n = 13,694) and nonresponders (n = 2834; Figure 1), we found that women who did not answer the UI questions were slightly younger and had lower BMI but were without differences in parity, delivery mode, and time since last delivery (Appendix 3).

In women aged younger than 50 years, when comparing forceps with spontaneous vaginal delivery, forceps delivery had a higher risk of SUI (OR, 1.42, 95% confidence interval [CI], 1.09−1.86) but not in women aged 50 years or older (OR, 0.96, 95% CI, 0.67-1.37) (Figure 2). The absolute increase of was

FIGURE 1
Flow chart showing eligibility of participants for analyses



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approximately 5.0% in bothersome SUI when comparing forceps delivery with spontaneous vaginal delivery in women aged younger than 50 years. No difference was found between spontaneous vaginal delivery and vacuum in either among those aged 50 years or 50 years or older (Figure 2).

When comparing forceps with vacuum delivery, forceps had again a higher risk of SUI in women aged younger than 50 years (OR, 1.76, 95% CI ,1.20−2.60) but not in women aged 50 years or older (Figure 2). When comparing forceps delivery with spontaneous vaginal delivery, forceps delivery had a nearly significant increased risk of UUI in women aged younger than 50 years (OR, 1.39, 95% CI, 0.98−1.97) but not in women aged 50 years or older (Figure 3).

In other analyses of UUI, there were no statistically significant differences between different modes of vaginal delivery (Figure 3). Finally, in sensitivity analyses with adjustment for the weight of the each participant's heaviest baby, we found no material differences in the estimates (Appendix 4).

Comment

In this large, population-based study of women across a wide age range, forceps delivery was associated with a significantly increased long-term risk of SUI among women aged younger than 50 years, but there was no longer a measurable impact for women aged 50 years or older. For UUI there was a nearly significant impact on the risk of UUI with forceps among women aged younger than 50 years.

The strengths of the current study include a study population representative of the general population in numerous aspects, including income, age distribution, morbidity and mortality,[15] assessment of urinary incontinence symptoms with validated instruments, adjustment for major established risk factors of SUI and UUI, and linking of incontinence data to the Medical Birth Registry of Norway, which covers all births in Norway since 1967. Furthermore, our material was unaffected by the selection bias typical of clinic-based studies as a result of treatment seeking. Finally, we not only the estimated relative effects but also provided absolute estimates.

This study has some limitations. First, although this is the largest available study of the impact of different types of operative delivery on UI subtypes, we did not have enough statistical power for longitudinal analyses. Second, women in this study were predominantly of European heritage, and results should be interpreted with caution for other ethnic groups. Third, we do not know how many of the women were incontinent before deliveries. Fourth, there may be confounding between the nature of the delivery and the choice of delivery method: clinicians may have chosen forceps for more obstructed labors, with greater cephalopelvic disproportion.

Given the long time period over which eligible women for these analyses might have delivered (1967−2008), it can be questioned whether these results are generalizable to current obstetric practice. Certainly in Norway during these decades there were measurable shifts in practice, with more cesarean deliveries, more vacuum deliveries, and a rise and then fall in forceps deliveries.[16] It is unclear whether the changes in frequency of use of the procedures are associated with different impacts on incontinence; however, we adjusted both for maternal age and years since last delivery in multivariate analyses, which should have helped to control for differences because of changes in proportions of each kind of delivery over time.

We considered carefully the choice of covariates in multivariate analyses. Although associations in the literature between perineal trauma and UI are inconsistent,[17-19] this may be one mediator or marker of the association of mode of birth and incontinence. We

TABLE
Age distribution, demographic characteristics, and prevalence of moderate to severe stress and urgency urinary incontinence among the 13,694 included women[a]

Characteristics	SVD (n = 12,276) Mean ± SD/n (%)	Vacuum (n = 713) n (%)/mean	Forceps (n = 705) n (%)/mean
Age, y[b]			
Mean	47.2 ± 10.52	43.5 ± 9.90	46.7 ± 10.01
<50	6896 (56.2)	520 (72.9)	437 (62.0)
≥50	5380 (43.8)	193 (27.1)	268 (38.0)
Years since last delivery[b]	18.30 ± 10.58	13.32 ± 9.42	16.47 ± 15.89
Parity[b]	2.38 ± 0.87	2.23 ± 0.89	2.34 ± 0.87
BMI, kg/m^2			
<25	5348 (43.6)	298 (41.8)	304 (43.1)
25–29.9	4649 (37.9)	262 (36.7)	269 (38.2)
≥30	2279 (18.5)	153 (21.5)	132 (18.7)
Stress urinary incontinence[c]	1553 (12.7)	84 (11.8)	108 (15.3)
<50 years	780 (11.3)	51 (9.8)	72 (16.5)
≥50 years	773 (14.4)	33 (17.1)	36 (13.4)
Urgency urinary incontinence[c]	1026 (8.4)	60 (8.4)	71 (10.1)
<50 years	411 (6.0)	33 (6.3)	38 (8.7)
≥50 years	615 (11.4)	27 (14.0)	33 (12.3)

SVD, spontaneous vaginal delivery.

[a] Spontaneous vaginal delivery indicates a history of spontaneous vaginal deliveries only. Vacuum indicates a history of at least 1 vacuum delivery but no forceps deliveries. Forceps indicates a history of at least 1 forceps delivery but no vacuum deliveries; [b] Value of $P < .05$ regarding between-group differences; [c] We defined women reporting stress urinary incontinence (with or without urgency urinary incontinence) and urgency urinary incontinence (with or without stress urinary incontinence) with severity of moderate or severe as having the condition.

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were not, however, able to adjust for episiotomy or perineal trauma. Epidural may increase the use of forceps or vacuum[20] but was not available in our data.

Birthweight, and particularly weight of the heaviest baby delivered by a woman, have been previously associated with a risk of incontinence.[21-23] We did not find an association between birthweight and mode of delivery but nevertheless tested the main model with and without inclusion of the weight of each participant's heaviest baby, finding no material difference.

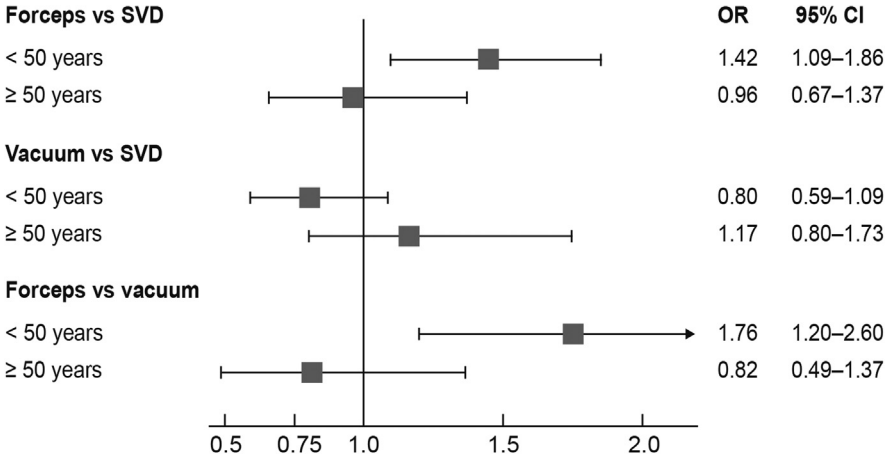
In common with almost all surveys of UI, the response rate for UI items was less than for questions about less stigmatizing conditions. Approximately 17% of potentially eligible women did not answer the incontinence questions. We found that nonresponders were slightly younger and thinner than responders but found no differences in other characteristics. How this nonresponse might have had an impact on estimates of association between mode of delivery and UI remains uncertain.

There are no randomized trials comparing the risk of SUI or UUI between spontaneous vaginal delivery, vacuum and forceps deliveries, or observational studies comparing the risk of SUI or UUI between vacuum and forceps deliveries. In the Norwegian EPINCONT study,[24] also using HUNT2 data, results were given for any incontinence, whereas the current study defines cases based on moderate or severe stress cases and distinguishes SUI and UUI.

The former study also compared vacuum deliveries with all other vaginal deliveries, that is, a combination of spontaneous vaginal deliveries and forceps deliveries, and compared forceps deliveries with a combination of spontaneous vaginal deliveries and vacuum deliveries. This means that both control and comparison groups included 1 form of instrumental delivery; this was especially relevant because 46% of the instrumental deliveries were vacuum and 54% forceps. They did not show any difference in the risk of SUI when comparing spontaneous vaginal delivery and forceps (OR, 0.8 95% CI, 0.7–1.0).

In a recent systematic review,[6] no difference was found in the long-term prevalence of SUI between vacuum delivery and spontaneous vaginal delivery (2 studies[13,25]; OR, 1.10, 95% CI, 0.80–1.51), concurring with our current analysis. However, in the same systematic review,[6] no difference was found in the risk of SUI between forceps and spontaneous vaginal delivery (3 studies[13,26,27];

FIGURE 2
Age-stratified impact of mode of vaginal delivery on SUI



Age-stratified, younger than age 50 years vs age 50 years or older, impact of mode of vaginal delivery on SUI in the multivariate analyses. The analyses were adjusted for age, body mass index, parity, and years since last delivery.

CI, confidence interval; *OR* odds ratio; *SUI*, stress urinary incontinence; *SVD*, spontaneous vaginal delivery.

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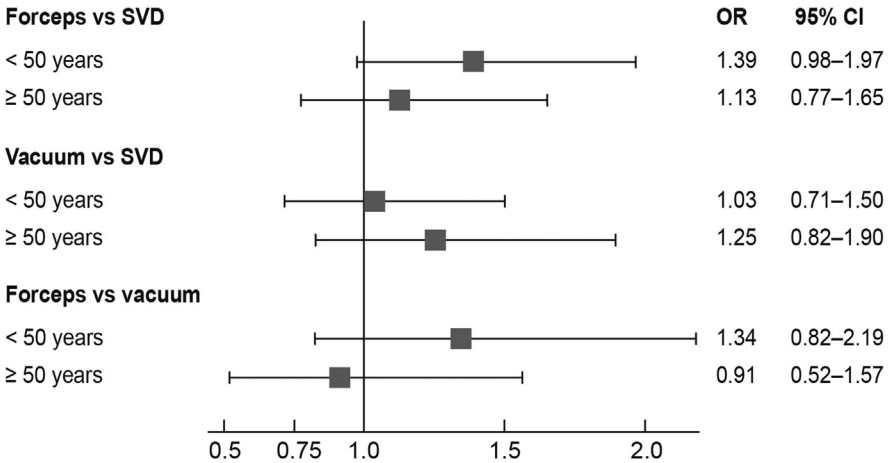
OR, 1.16; 95% CI, 0.71−1.89; heterogeneity: $P = .06$, $I^2 = 65\%$).

This pooled analysis is inconsistent with our results. However, here we include substantially more participants than there were in these 3 earlier studies combined.[13,26-27] Furthermore, there are methodological concerns regarding earlier work, including reliance on maternal recall of obstetric exposures,[26,27] which is known to be unreliable for classification of forceps and vacuum.[28]

FIGURE 3
Age-stratified impact of mode of vaginal delivery on UUI



Age-stratified, younger than age 50 years vs age 50 years or older, impact of mode of vaginal delivery on UUI in the multivariate analyses.[a]

[a] Analyses adjusted for age, body mass index, parity, and years since last delivery.

CI, confidence interval; *OR* odds ratio; *SVD*, spontaneous vaginal delivery; *UUI*, urgency urinary incontinence.

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Many UI risk factors (BMI and comorbidities) associate with age.[29,30] Our results concur with previous studies reporting that the association of vaginal delivery on UI diminish in older age.[6] There is still probably an underlying association with mode of delivery in older age, but it is more difficult to detect because of competing causes of incontinence that, in this context, represent random error.

There remains wide practice variation in both the overall rates of operative delivery and choice of method.[31] Forceps are less likely than vacuum to fail to achieve a vaginal birth.[31] However, with forceps facial injury is more likely,[31] and forceps delivery is associated with an increased prevalence of pelvic organ prolapse, whereas vacuum delivery is not.[13, 31]

In low- and middle-income countries, less than 1% of institutional deliveries are operative deliveries with vacuum preferred over forceps.[32] In the United States between 2005 and 2013, approximately 5% of the deliveries were vacuum and 1% forceps deliveries.[33] In 2016, approximately 9% of deliveries were vacuum and 1.6% forceps deliveries in Norway.[16]

For informed decision making between forceps and vacuum, we need accurate, unbiased estimates about their immediate and long-term consequences. These data provide an additional rationale for vacuum over forceps, at least when considering long-term incontinence. The estimates provided here are useful when counselling women about the risk and benefits of different delivery modes. ■

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Author and article information

From the Department of Obstetrics and Gynecology, Kuopio University Hospital, Kuopio, Finland (Dr Tähtinen); the Department of Obstetrics and Gynecology, Tampere University Hospital, Tampere, Finland (Dr Tähtinen); the Department of Epidemiology and Biostatistics, Imperial College London, London, United Kingdom (Dr Cartwright); the Department of Urogynecology, Oxford University Hospitals National Health Service Trust, Oxford, United Kingdom (Dr Cartwright); the Department of Research, Comprehensive Cancer Organisation, Utrecht, The Netherlands (Dr Vernooij); the Department of Global Public Health and Primary Care, University of Bergen, Bergen, Norway (Drs Rortveit and Hunskaar); the Departments of Health Research Methods, Evidence, and Impact and Medicine, McMaster University, Hamilton, ON, Canada (Dr Guyatt); and the Departments of Urology and Public Health, University of Helsinki and Helsinki University Hospital, Helsinki, Finland (Dr Tikkinen).

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Corresponding author: Kari A.O. Tikkinen, MD, PhD. kari.tikkinen@gmail.com

APPENDIX 1
Questions to assess urinary incontinence with response categorization[a]

Symptom	Defining question	Response categorization or scores	
		Normal	Abnormal
Urinary leakage	Do you have involuntary loss of urine?	No	Yes
Stress urinary incontinence	Do you leak urine when you cough, sneeze, laugh, or lift something heavy?	No	Yes
Urgency urinary incontinence	Do you have involuntary loss of urine in connection with sudden and strong urge to void?	No	Yes
Frequency of leakage[a]	How often do you have involuntary loss of urine?"	1: Less than once a month 2: One or more times a month 3: One or more times a week 4: Every day and/or night	
Amount of leakage[a]	How much urine do you leak each time?	1: Drops or little	2: Small amount or large amount

[a] Sandvik Severity Index is obtained by multiplying the scores for questions amount of leakage and frequency of leakage: 1—2 indicates slight incontinence, 3—4, moderate incontinence, and 6—8, severe incontinence.[10]

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Appendix 2 Longitudinal analyses

A total of 6566 women participated in both surveys (HUNT2 and HUNT3). We performed longitudinal analyses looking for incidental cases of SUI or UUI between HUNT2 (baseline) and HUNT3 (follow-up). To these analyses, we included only nulliparous women who were continent at the baseline (HUNT2) and who delivered before HUNT3 (except if they were surveyed during the first postpartum year or during pregnancy at either baseline or follow-up). The same prespecified known risk factors were treated as confounders as in the cross-sectional analyses: age, body mass index (<25, 25—30; ≥ 30 kg/m^2), parity, and years since last delivery. Parity and years since last delivery were obtained from Medical Birth Registry of Norway.[11]

A total of 391 women were nulliparous at the baseline. Four women had SUI at the baseline and were excluded from longitudinal SUI analyses; 3 had UUI and were excluded from longitudinal UUI analyses.

In total, 387 women were included to the longitudinal SUI analyses and 388 women to the longitudinal UUI analyses. At the follow-up, 48 of the women (12.4%) had moderate to severe SUI and 16 (4.1%) had moderate to severe UUI. Of those with SUI at the follow-up, 38 women had SVD, 7 vacuum and 3 forceps deliveries. Of those with UUI at the follow-up, 13 women had SVD, 2 vacuum and 1 forceps deliveries. Statistical power for these longitudinal analyses was too small for reliable, precise estimates (see table below).

Outcome	Comparison[a]	OR	95% CI
SUI	Vacuum delivery vs SVD	2.08	0.84—5.11
	Forceps delivery vs SVD	1.16	0.33—4.08
UUI	Vacuum delivery vs SVD	1.53	0.33—7.08
	Forceps delivery vs SVD	1.11	0.14—8.89

CI, confidence interval; *HUNT*, Nord-Trøndelag Health; *OR* odds ratio; *SUI*, stress urinary incontinence; *SVD*, spontaneous vaginal delivery; *UUI*, urgency urinary incontinence.

[a] Spontaneous vaginal delivery indicates a history of spontaneous vaginal deliveries only. Vacuum indicates a history of at least 1 vacuum delivery but no forceps deliveries. Forceps indicates a history of at least 1 forceps delivery but no vacuum deliveries.

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APPENDIX 3
Baseline characteristics for responders and nonresponders to urinary incontinence questions

Characteristics	Responders (n = 13,694) Mean ± SD/n (%)	Nonresponders (n = 2834) Mean ± SD/n (%)
Age, y[a]	Mean 46.97 ± 10.49	Mean 43.73 ± 10.26
<50	7853 (57.3)	1476 (71.2)
≥50	5841 (42.7)	598 (28.8)
Years since last delivery	17.95 ± 10.53	15.45 ± 10.29
Parity	2.37 ± 0.87	2.46 ± 0.92
BMI, kg/m^2[a]		
<25	5950 (43.4)	975 (47.6))
25–29.9	5180 (37.8)	711 (34.7)
≥30	2564 (18.7)	363 (17.7)
Delivery mode[b]		
SVD	12,276 (89.2)	2527 (89.9)
Vacuum	713 (5.2)	146 (5.2)
Forceps	705 (5.0)	141 (5.0)

BMI, body mass index; *SVD*, spontaneous vaginal delivery.

[a] Information on age and BMI was available for 63.6% and 71.6%, respectively; [b] Twenty women delivered both vacuum and forceps in nonresponders group and are excluded.

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APPENDIX 4
Sensitivity analyses[a] including 13,686 women[b]

Outcome		Comparison	OR	95% CI
Age <50 y	SUI	Forceps vs vacuum	1.76	1.19–2.60
		Vacuum vs SVD	0.81	0.60–1.10
		Forceps vs SVD	1.43	1.09–1.87
		All assisted vs SVD	1.09	0.88–1.34
	UUI	Forceps vs vacuum	1.34	0.82–2.18
		Vacuum vs SVD	1.05	0.72–1.53
		Forceps vs SVD	1.40	0.99–2.00
		All assisted vs SVD	1.22	0.93–1.59
Age ≥50 y	SUI	Forceps vs vacuum	0.83	0.49–1.37
		Vacuum vs SVD	1.15	0.78–1.70
		Forceps vs SVD	0.95	0.66–1.37
		All assisted vs SVD	1.04	0.79–1.36
	UUI	Forceps vs vacuum	0.91	0.52–1.57
		Vacuum vs SVD	1.25	0.82–1.91
		Forceps vs SVD	1.13	0.77–1.65
		All assisted vs SVD	1.18	0.88–1.58

CI, confidence interval; *OR* odds ratio; *SUI*, stress urinary incontinence; *SVD*, spontaneous vaginal delivery; *UUI*, urgency urinary incontinence.

[a] Analyses were adjusted for age, body mass index, parity, years since last delivery, and weight of each participant's heaviest baby; [b] Correct birthweight information was missing from 8 women.

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