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Mode of birth and long-term sexual health – follow-up of the Danish National Birth Cohort

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Manuscripts

Mode of birth and long-term sexual health

– follow-up of the Danish National Birth Cohort

Sarah Hjorth MSc^{1,2}, Helene Kirkegaard PhD¹, Jørn Olsen PhD³, Jim G Thornton MD⁴,
Ellen A Nohr PhD^{1,5}

¹ Research Unit of Gynecology and Obstetrics, Department of Clinical Research, University of Southern Denmark, Odense, Denmark

² Current address: PharmacoEpidemiology and Drug Safety Research Group, Department of Pharmacy, Faculty of Mathematics and Natural Sciences, University of Oslo, Oslo, Norway

³ Department of Clinical Epidemiology, Aarhus University Hospital, Aarhus, Denmark

⁴ Department of Child Health, Obstetrics and Gynaecology, University of Nottingham, Nottingham, UK

⁵ Centre of Women's, Family and Child Health, University of South-Eastern Norway, Kongsberg, Norway

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Correspondence to

Sarah Hjorth

PharmacoEpidemiology and Drug Safety Research Group, Department of Pharmacy, Faculty of

Mathematics and Natural Sciences, University of Oslo, P.O 1068, Blindern, 0316 Oslo, Norway

email: s.h.andersen@farmasi.uio.no

telephone : +45 50564818

ABSTRACT

Objectives

To investigate the relation between mode of birth and women's long-term sexual health.

Design

Maternal follow-up of the Danish National Birth Cohort (1996-2002) in 2013-2014 including questions on sexual health. Logistic regression was used to relate registry-based information about mode of birth and perineal tears with data on sexual problems.

Setting

Denmark.

Participants

Of 82 569 eligible mothers in the Danish National Birth Cohort, 43 639 (53%) completed the follow-up. Of these, 37 417 women had a partner at follow-up, and answered at least one question on sexual health.

Main outcome measures

Self-reported sexual health.

Results

Participants were on average 44 years old, and 16 years after their first birth. The frequency of sexual problems among women with only spontaneous vaginal deliveries, the reference group, was 37%. For women who only had caesarean births, more problems were reported (OR 1.18; 95% CI 1.09 to 1.28). For women who had a spontaneous vaginal birth subsequent to a caesarean, as well as for women with only vaginal births who had experienced one or more instrumental vaginal deliveries, the odds of sexual problems did not differ from women with only spontaneous vaginal births (OR 1.00; 95% CI 0.91 to 1.11) and (OR 1.01; 95% CI 0.95 to 1.08) respectively.

Conclusions

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2 These findings indicate that caesarean section does not protect against long-term sexual problems. The
3 data from women who had a vaginal birth after a caesarean section suggests that vaginal birth is
4 protective of long-term sexual problems rather than caesarean section causing them.
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7 **Keywords**

8 Mode of birth, sexual health, caesarean section, dyspareunia, Danish National Birth Cohort
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12 **STRENGTHS AND LIMITATIONS OF THIS STUDY**

- 14 • This study is the largest study on mode of birth and long-term sexual health to date with 37 417
15 participants, allowing for a detailed investigation of the exposure.
- 16 • Information on mode of birth was obtained from registries, limiting the risk of differential
17 misclassification.
- 18 • Non-participation in the maternal follow-up was 47%, which may limit the generalisability of
19 the study.
- 20 • Residual confounding, including confounding by birth route indication, cannot be ruled out, but
21 the results were stable in sensitivity analyses.
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30 **INTRODUCTION**

31 Sexual health is an important part of reproductive health,¹ and quality of life.² It is influenced by many
32 factors, including women's reproductive history.³ Short term studies have shown that mode of birth,
33 and perineal injury are associated with sexual problems up to 18 months post-partum.³⁻⁶ Although the
34 only randomised trial of mode of birth, where one group of women was allocated to planned caesarean
35 section and the other to planned vaginal birth, reported no significant differences after two years of
36 follow-up, the point estimates for pain and being unhappy during sex marginally favoured caesarean
37 birth.⁷ There is also a widespread lay belief that caesarean birth, perhaps by maintaining vaginal tone,
38 or avoiding perineal injury, might improve sexual function.
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47 The results of longer-term studies are inconsistent.⁸⁻¹² One found reduced desire in women with
48 previous instrumental birth, and reduced lubrication in women with a history including both caesarean
49 section and vaginal birth.¹² Another reported no associations between mode of birth and sexual
50 problems.¹⁰ For women with anal sphincter tears, some studies found no effect,^{9,12} while others
51 observed a higher prevalence of reduced lubrication¹⁰ or dyspareunia.¹¹
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4 We investigated the associations between reproductive history and long-term sexual problems in a
5 large cohort of Danish mothers. Our hypotheses were that instrumental vaginal birth would be
6 associated with a higher risk of sexual problems than spontaneous birth whereas caesarean section
7 would not, and that women with birth induced perineal injuries would have more sexual problems than
8 women without.
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13 14 **METHODS**

15 **Data sources**

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17 The study was based on data from the Danish National Birth Cohort.^{13,14} The cohort enrolled 91 386
18 women in early pregnancy between 1996 and 2002, about 30% of births in that period.¹⁵ The first
19 interview, conducted around week 16 of gestation, included information on health, lifestyle, and socio-
20 occupational factors. Participants consented to use of their information from Danish health and social
21 registries. Between December 2013 and December 2014, participants were invited to respond to a
22 questionnaire on physical, mental, and sexual health. Altogether, 53% (43 639 women) of eligible
23 mothers participated.¹⁶
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31 Under Danish law, ethical permission is not required for public registry-based studies.¹⁷ The Danish
32 National Birth Cohort was initially approved by the Committee on Biomedical Research Ethics
33 (reference no. [KF] 01-471/94) and all participants gave written, informed consent. This study was also
34 approved by the Danish Data Protection Agency (approval no. 2014-41-2848).
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40 **Outcome**

41 The outcome was self-reported sexual health. Participants provided information about whether their
42 sexual needs had been met in the past year, the frequency of sexual activity with a partner, their
43 experience of dyspareunia, vaginismus, insufficient lubrication, and difficulty in getting an orgasm.
44 They were also asked about sexual desire, and whether any lack of desire was considered problematic
45 by them or their partner. Questions were adapted from the Danish National Health Survey¹⁸
46 (supplemental table 1).
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2 Four types of sexual difficulties were dichotomised into the presence or absence of a sexual problem in
3 the past year. Reduced lubrication or difficulty in achieving orgasm were considered a problem if the
4 women had answered that they 'often' or 'always' had experienced these difficulties during sex with
5 their partner. Dyspareunia was classified by location, at the vaginal introitus (entry dyspareunia) and/or
6 deep in the abdomen (deep dyspareunia), and considered a problem if women reported that
7 they 'sometimes', 'often' or 'always' had either type. In addition, we defined frequent dyspareunia if it
8 was present 'often' or 'always'. Reduced sexual desire was considered a problem if women both
9 'sometimes', 'often' or 'always' experienced it, and also considered it a problem. All four specific
10 sexual problems (reduced lubrication, difficulty in achieving orgasm, dyspareunia, and reduced sexual
11 desire) were combined in one outcome, 'the presence or absence of one or more sexual problems
12 within the past year'.
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22 **Exposures**

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24 Exposures were mode of birth and perineal tears from the woman's entire reproductive history. These
25 were obtained from the Danish Medical Birth Registry, which contains data about all live and still
26 births since 1973,¹⁹ and from the National Patient Registry, which contains data about all contacts with
27 Danish hospitals since 1977.²⁰ Registry data up to the date the woman answered the follow-up
28 questionnaire were linked to cohort participants through personal identification numbers. Mode of birth
29 was categorised as only spontaneous vaginal births, one or more instrumental vaginal deliveries in
30 women with only vaginal births, only caesarean sections, one or more spontaneous vaginal births after
31 a first caesarean section, instrumental vaginal birth in women who birthed vaginally after a first
32 caesarean section, and caesarean section after vaginal birth.
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42 Data on perineal tears were first kept and stored in Denmark in 1994 using ICD10. For this study,
43 perineal tears were categorised as no tear, first (ICD10 code O70.0), second (O70.1), third (O70.2), or
44 fourth degree tear (O70.3), or episiotomy (procedure code KTMD00). During the years, the women
45 from the cohort gave birth, it was common practice to register only sutured tears, and many first degree
46 tears were left unsutured. No tear and first degree tears were therefore combined into one category. As
47 fourth degree tears amount to only 1% of perineal tears, they were combined with third degree tears in
48 a single category 'anal sphincter tear'. Data on third and fourth degree tears analysed separately is
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2 available in supplemental table 2. Anal sphincter tear together with an episiotomy was categorised as
3 the former.
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7 **Potential covariates**

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9 Covariates were chosen a priori based on a literature review, and depicted in directed acyclic graphs²¹
10 (supplemental figure 1). Maternal age at first birth, and calendar year at first birth were obtained from
11 the Medical Birth Registry. Information about socio-occupational status, pre-pregnant body mass index
12 (BMI), mental-, and physical health, and smoking and exercise in pregnancy came from the woman's
13 first interview in the Danish National Birth Cohort, and was thus related to her first childbirth in the
14 cohort. For 51% of participants, this was also their first birth. Socio-occupational status was
15 categorised as high (four or more years of education after high school, or job as manager), middle
16 (skilled manual work, office or service work), or low (unskilled work or unemployment).²² Diseases
17 were defined as those that had been diagnosed by a physician, and included hypertensive disorders,
18 diseases of the heart, thyroid, or musculoskeletal system, epilepsy, diabetes, gynaecological diseases,
19 and mental illness. Self-assessed health at the first pregnancy, smoking in pregnancy, and exercise in
20 pregnancy were categorised as shown in table 1.
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31 **Study population**

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33 Women who participated in the follow-up and answered at least one question on sexual health (n=42
34 132) were eligible. Two separate analyses were done, one for mode of birth, and one for degree of
35 perineal tear. Study populations varied slightly in the two analyses (figure 1). For both study
36 populations, we excluded 4 715 (11%) women without a partner, as they were not considered
37 comparable with women with a partner when it came to sexual activity and sexual problems. The study
38 included women with male and/or female partners. This left 37 417 women in the study population for
39 mode of birth. For the analysis on perineal tears, 3 240 women (8%) who only had caesarean sections,
40 and 4 920 women (12%) with births before 1994, when degree of perineal tear registration started, were
41 also excluded, leaving 29 253 women in the study population.
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53 **Participant and public involvement**

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2 Some study participants were involved in developing and testing the questionnaire in the maternal
3 follow-up. The results of the research conducted in the Danish National Birth Cohort are available at
4 www.dnbc.dk.
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8 **Statistical analysis**

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10 To estimate the association between mode of birth, or degree of perineal tear, and the prevalence of
11 sexual problems, we used logistic regression for calculating odds ratios (ORs) with 95% confidence
12 intervals (CIs). For mode of birth, the reference group was women who had only delivered
13 spontaneously. For perineal tears, the reference group was "no tear or first degree tear". Multiple
14 logistic regressions were adjusted for age, year at first birth, and pre-pregnant BMI as continuous
15 variables, and socio-occupational status, self-assessed health, disease, exercise, and smoking in
16 pregnancy as categorical variables. The number of answers available for analysis for each outcome
17 differed, as the response option 'I do not wish to answer this question' was provided for all questions
18 on sexual health, and only participants with complete information on exposure and outcome were
19 analysed. To address missing data on covariates, multivariate imputation by chained equations was
20 done, and the number of datasets created was 20, as no difference in results was seen when moving
21 from ten to 20 datasets. As recommended by Sterne et al.,²³ both exposure, outcome, and covariates
22 with complete information were included in the imputation model. Complete case analyses were done
23 as well, and the results did not differ substantially from the results based on multiple imputation
24 (supplemental tables 3 and 4). For non-participants in the maternal follow-up, we also had available
25 data on mode of birth and degree of tear, and the distributions were compared to that observed in
26 participants and found to be similar (supplemental table 5). Because some categories of mode of birth
27 could only include women with more than one child, the categorisation may be seen as a conditioning
28 on parity or future events. In a sensitivity analysis, we therefore adjusted for parity and year at last
29 birth, even though they were also considered intermediates in the directed acyclic graph. As vaginismus
30 is associated with a lower prevalence of vaginal births, a second sensitivity analysis excluded women
31 with vaginismus. In a third sensitivity analysis, the population was restricted to women who had their
32 first child in the Danish National Birth Cohort, as women who choose to have another child may
33 represent a selected group, where women who have the worst experiences of childbirth, or who have
34 sequelae, are under-represented. All analyses were done using Stata 13.1 (StataCorp, College Station,
35 Texas, USA).
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RESULTS

The mean age of participants at follow-up was 44 years (SD 4.4), and the mean interval since the women's first birth to the maternal follow-up 16 years (SD 3.8, range 11 to 40 years). Socio-occupational status, BMI, and smoking and exercise practice in pregnancy are shown in table 1. Most women, 23 608 (63%), had delivered all of their children spontaneously. For 6 359 women (17%), their reproductive history included at least one instrumental vaginal birth, almost all of which were vacuum extractions (99%). Some of these women also had a caesarean section in their reproductive history. In 8 806 women (24%), at least one birth had been by caesarean section, and 3 244 women (8%) had only caesarean sections.

Table 1. Participant characteristics by mode of birth

	Mode of birth					In V (n)
	All (n=37 417)	Only spontaneous deliveries (n=23 608)	Instrumental vaginal birth, ever (n=5 003)	Only c-sections (n=3 244)	Spontaneous VBAC (n=2 038)	
Age at first birth, n (%)						
<25	7 140 (19)	4 864 (21)	775 (15)	363 (11)	356 (17)	73
25–29	19 839 (53)	12 758 (54)	2 656 (53)	1 433 (44)	1 144 (56)	23
30–34	8 614 (23)	5 063 (21)	1 280 (26)	1 024 (32)	465 (23)	12
≥35	1 824 (5)	923 (4)	292 (6)	424 (13)	73 (4)	24
Socio-occupational status, n (%)*						
Low	2 233 (6)	1 393 (6)	265 (6)	202 (7)	123 (6)	23
Middle	11 832 (34)	7 444 (34)	1 562 (33)	1 056 (35)	656 (34)	13
High	21 059 (60)	13 318 (60)	2 875 (61)	1 779 (59)	1 133 (59)	20
Missing	2 293	1 453	301	207	126	27
Prepregnant BMI, n (%)*						
<18.5	1 417 (4)	906 (4)	196 (4)	87 (3)	82 (4)	20
18.5–24.9	24 554 (71)	15 991 (73)	3 275 (70)	1 843 (62)	1 286 (68)	20
25.0–29.9	6 405 (18)	3 748 (17)	899 (19)	697 (23)	369 (20)	93
≥30.0	2 321 (7)	1 249 (6)	278 (6)	355 (12)	150 (8)	37
Missing	2 720	1 714	355	262	151	33
Exercise in pregnancy, min/week, n (%)*						
None	21 156 (60)	13 137 (59)	2 881 (61)	1 888 (62)	1 149 (60)	27
1–180	11 184 (32)	7 222 (33)	1 475 (31)	900 (30)	615 (32)	13
>180	2 826 (8)	1 825 (8)	348 (7)	255 (8)	148 (8)	33
Missing	2 251	1 424	299	201	126	23

Smoking in pregnancy, n (%)*

No smoking	28 295 (80)	17 973 (80)	3 774 (80)	2 372 (77)	1 545 (80)
Smoking cessation	3 099 (9)	1 892 (8)	425 (9)	318 (10)	173 (9)
Smoking	4062 (11)	2 489 (11)	536 (11)	378 (12)	222 (11)
Missing	1 961	1 254	268	176	98

Self-assessed health, n (%)*

Very good	19 750 (56)	12 630 (57)	2 642 (56)	1 631 (53)	1 079 (56)
Normal	14 578 (41)	9 056 (41)	1 963 (42)	1 319 (43)	798 (41)
Not so good	970 (3)	576 (3)	116 (2)	109 (4)	47 (2)
Missing	2 119	1 346	282	185	114

Presence of disease, n (%)*†

No	20 305 (58)	13 105 (59)	2 774 (59)	1 577 (52)	1 095 (57)
Yes	14 855 (42)	9 070 (41)	1 932 (41)	1 468 (48)	820 (43)
Missing	2 257	1 433	297	199	123

*Percentage of non-missing values.

†Diseases that, according to the women, had been confirmed by a physician, including hypertensive disorders, diseases of the heart, thyroid, or musculoskeletal system, epilepsy, diabetes, gynaecological diseases, and mental illness.

BMI: Body mass index. C-section: Caesarean section. VBAC: Vaginal birth after caesarean section.

Of the 36 691 women who answered the question on sexual needs, 25 289 women (69%) felt that their needs had been met completely or almost completely within the past year (supplemental table 1). Of the 35 710 women who answered all questions on sexual problems, 13 449 (38%) reported one or more sexual problems. Reduced or lacking sexual desire was the most prevalent sexual difficulty, and 7 945 women (22%) had experienced reduced desire to an extent that they found problematic for themselves. Reduced desire to an extent that the women felt was problematic for their partner was experienced by 35%.

Mode of birth

Compared to women with only spontaneous vaginal deliveries, there was no evidence for a difference in the prevalence of any sexual problems in women with instrumental vaginal deliveries (table 2). Odds for one or more sexual problems were increased in women who had only delivered by caesarean section (OR 1.18; 95% CI 1.09 to 1.28), in women who had an instrumental vaginal birth after caesarean section (OR 1.35; 95% CI 1.11 to 1.64), and in women who had a caesarean section after vaginal birth (OR 1.10; 95% CI 1.01 to 1.19), but not in women with spontaneous vaginal birth after caesarean section. The specific sexual problems that were more prevalent in women with a history of

caesarean section were reduced lubrication (OR=1.41, 95% CI 1.24 to 1.60) and dyspareunia (OR=1.78, 95% CI 1.59 to 1.99), including frequent dyspareunia (OR=2.82, 95% CI 2.32 to 3.41) (supplemental table 8). When asked about the localisation of the pain, odds ratios for women with only caesarean section were higher for entry dyspareunia (OR=2.76, 95% CI 2.36 to 3.24) than for deep dyspareunia (OR=1.25, 95% CI 1.08 to 1.45).

Table 2: Sexual problems by mode of birth.

	Only spontaneous deliveries	Instrumental vaginal birth, ever	Only c-sections	Spontaneous VBAC	Instrumental VBAC
One or more sexual problem(s), n=35 710					
Cases (%)	8 323 (37)	1 788 (37)	1 278 (42)	718 (37)	194 (45)
Crude OR (95% CI)	Reference	1.02 (0.96–1.09)	1.24 (1.15–1.34)	1.01 (0.92–1.11)	1.37 (1.14–1.66)
Adjusted OR* (95% CI)	Reference	1.01 (0.95–1.08)	1.18 (1.09–1.28)	1.00 (0.91–1.11)	1.35 (1.11–1.64)
Reduced desire, n=36 509					
Cases (%)	4 981 (22)	1 042 (21)	723 (23)	437 (22)	106 (24)
Crude OR (95% CI)	Reference	0.99 (0.92–1.07)	1.09 (1.00–1.19)	1.03 (0.92–1.15)	1.13 (0.91–1.41)
Adjusted OR* (95% CI)	Reference	0.99 (0.92–1.07)	1.05 (0.96–1.15)	1.03 (0.92–1.15)	1.13 (0.91–1.41)
Difficulty in obtaining orgasm, n=36 019					
Cases (%)	2 861 (13)	641 (13)	421 (14)	255 (13)	73 (17)
Crude OR (95% CI)	Reference	1.07 (0.97–1.17)	1.10 (0.99–1.23)	1.04 (0.91–1.20)	1.39 (1.08–1.79)
Adjusted OR* (95% CI)	Reference	1.06 (0.96–1.16)	1.06 (0.95–1.18)	1.04 (0.91–1.19)	1.38 (1.07–1.78)
Insufficient lubrication, n=36 148					
Cases (%)	1 700 (7)	383 (8)	344 (11)	138 (7)	46 (10)
Crude OR (95% CI)	Reference	1.07 (0.95–1.20)	1.55 (1.37–1.76)	0.94 (0.78–1.12)	1.44 (1.06–1.96)
Adjusted OR* (95% CI)	Reference	1.01 (0.90–1.13)	1.41 (1.24–1.60)	0.92 (0.77–1.10)	1.35 (0.99–1.85)
Dyspareunia, n=36 266					
Cases (%)	2 040 (9)	446 (9)	467 (15)	170 (9)	57 (13)
Crude OR (95% CI)	Reference	1.03 (0.93–1.15)	1.81 (1.62–2.02)	0.96 (0.82–1.13)	1.50 (1.13–1.99)
Adjusted OR* (95% CI)	Reference	1.05 (0.94–1.17)	1.78 (1.59–1.99)	0.97 (0.82–1.14)	1.52 (1.14–2.01)
Entry dyspareunia, n=35 720					
Cases (%)	640 (3)	160 (3)	243 (8)	68 (4)	25 (6)
Crude OR (95% CI)	Reference	1.19 (1.00–1.42)	2.99 (2.57–3.49)	1.24 (0.96–1.60)	2.09 (1.38–3.15)
Adjusted OR* (95% CI)	Reference	1.14 (0.96–1.37)	2.76 (2.36–3.24)	1.24 (0.96–1.59)	2.03 (1.35–3.07)

Deep dyspareunia, n=35 720

Cases (%)	1 425 (6)	278 (6)	233 (8)	102 (5)	36 (8)
Crude OR (95% CI)	Reference	0.92 (0.80–1.05)	1.24 (1.07–1.43)	0.82 (0.67–1.01)	1.34 (0.95–1.89)
Adjusted OR* (95% CI)	Reference	0.96 (0.84–1.09)	1.25 (1.08–1.45)	0.83 (0.67–1.02)	1.38 (0.98–1.96)

*Adjusted for maternal age at first birth, calendar year at first birth, pre-pregnant body mass index, socio-occupational status, self-assessed health, disease, exercise in pregnancy, and smoking in pregnancy.

C-section: Caesarean section; CI: Confidence interval; OR: Odds ratio; VBAC: Vaginal birth after caesarean section.

Among women with one or more vaginal births, 16 404 (56%), had no tear or a first degree tear (supplemental table 10). Episiotomy was frequently used in 1997 to 2002, and 6 615 women (23%) had a second degree tear from a mediolateral episiotomy as their largest tear.

Neither second degree tears nor episiotomies were associated with increased odds of any of the studied sexual problems (table 3). Women with previous episiotomies had lower odds of deep dyspareunia (OR=0.87, 95% CI 0.77 to 0.99) than women with no tear or a first degree tear. Women with previous anal sphincter tears had moderately higher odds of reduced lubrication and entry dyspareunia (OR 1.20, 95% CI 1.01 to 1.43, & OR 1.34, 95% CI 1.04 to 1.73, respectively). The latter association was unaltered when frequent dyspareunia was considered (supplemental table 11).

Table 3: Sexual problems by degree of perineal tear.

	No tear/first degree	Second degree	Episiotomy	Anal sp
One or more sexual problem(s), n=27 992				
Cases (%)	5 882 (37)	1 560 (38)	2 278 (36)	716 (38)
Crude OR (95% CI)	Reference	1.04 (0.97–1.12)	0.95 (0.90–1.01)	1.03 (0.95–1.11)
Adjusted OR* (95% CI)	Reference	1.03 (0.96–1.11)	0.95 (0.90–1.01)	1.02 (0.95–1.10)
Reduced sexual desire, n=28 586				
Cases (%)	3 523 (22)	935 (22)	1 342 (21)	423 (22)
Crude OR (95% CI)	Reference	1.02 (0.94–1.11)	0.94 (0.87–1.00)	1.01 (0.93–1.10)
Adjusted OR* (95% CI)	Reference	1.01 (0.93–1.10)	0.95 (0.88–1.01)	1.00 (0.93–1.09)
Difficulty in obtaining orgasm, n=28 217				
Cases (%)	2 006 (13)	553 (14)	817 (13)	261 (14)
Crude OR (95% CI)	Reference	1.08 (0.97–1.19)	1.02 (0.93–1.11)	1.11 (0.95–1.29)
Adjusted OR* (95% CI)	Reference	1.07 (0.96–1.18)	1.01 (0.93–1.11)	1.09 (0.95–1.24)
Insufficient lubrication, n=28 308				
Cases (%)	1 133 (7)	314 (8)	481 (8)	163 (9)

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2	Crude OR (95% CI)	Reference	1.08 (0.95–1.23)	1.06 (0.95–1.19)	1.22 (1.05–1.41)
3	Adjusted OR* (95% CI)	Reference	1.09 (0.96–1.25)	1.02 (0.91–1.14)	1.20 (1.05–1.37)
4					
5	Dyspareunia, n=28 398				
6	Cases (%)	1 469 (9)	372 (9)	562 (9)	184 (10)
7	Crude OR (95% CI)	Reference	0.98 (0.87–1.10)	0.95 (0.86–1.05)	1.05 (0.95–1.16)
8	Adjusted OR* (95% CI)	Reference	0.97 (0.86–1.10)	0.96 (0.87–1.07)	1.07 (0.97–1.18)
9					
10	Entry dyspareunia, n=28 006				
11	Cases (%)	453 (3)	115 (3)	201 (3)	74 (4)
12	Crude OR (95% CI)	Reference	0.98 (0.80–1.21)	1.11 (0.94–1.31)	1.38 (1.17–1.61)
13	Adjusted OR* (95% CI)	Reference	0.98 (0.79–1.20)	1.09 (0.92–1.30)	1.34 (1.14–1.57)
14					
15	Deep dyspareunia, n=28 006				
16	Cases (%)	1 035 (7)	265 (7)	355 (6)	117 (6)
17	Crude OR (95% CI)	Reference	0.99 (0.86–1.14)	0.85 (0.75–0.96)	0.94 (0.84–1.05)
18	Adjusted OR* (95% CI)	Reference	0.98 (0.85–1.13)	0.87 (0.77–0.99)	0.97 (0.87–1.08)
19					
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21					

*Adjusted for maternal age at first birth, calendar year at first birth, pre-pregnant body mass index, socio-occupational status, self-assessed health, disease, exercise in pregnancy, and smoking in pregnancy.
CI: Confidence interval; OR: Odds ratio.

In sensitivity analyses, adjusting for parity and year at last birth did not change the results (data not shown), and restricting the population to women who had their first birth in the Danish National Birth Cohort only changed the results marginally (supplemental tables 6 and 7). Vaginismus was rare in this study population (1%), but more prevalent in women who had a history of caesarean section. However, results were not substantially altered when we excluded women with vaginismus (supplemental table 9).

DISCUSSION

In this large sample of Danish mothers, a history of caesarean section was associated with an increased risk of sexual problems in midlife compared with women who had only birthed vaginally. The estimated effect sizes were small to moderate, but if causative would be clinically important. For example, women who had only given birth by caesarean section had a relative risk of 1.11 of sexual problems in later life. This 11 percent proportional increase amounts to a five percent absolute increase from 37 to 42 percent. In contrast, instrumental vaginal birth was not associated with long-term sexual problems. Among women who had delivered by caesarean but had a subsequent spontaneous vaginal

1
2 birth, the risk of long-term sexual problems was similar to those who had only birthed vaginally. Less
3 deep dyspareunia was reported by women with episiotomies.
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7 Strengths of this study include study size, and long-term follow-up with linkage to registry data,
8 allowing a detailed investigation of exposures while limiting the risk of differential misclassification.
9 Limitations include the 47% non-participation. A recent study found that participants in the maternal
10 follow-up were older, and of higher socio-occupational status and healthier lifestyle than non-
11 participants, but also that selected exposure-outcome associations were not substantially affected by
12 selection bias.¹⁶ However, the relatively high socio-occupational level of participants could affect
13 generalisability. Residual confounding, including confounding by time varying factors and
14 confounding by indication, should be considered. A study found lower prevalence of vaginal births in
15 women with vaginismus.²⁴ It is possible that some of the biopsychological mechanisms that cause
16 sexual problems may also alter the likelihood of vaginal birth. Among these mechanisms could be
17 mental illness, which we adjusted for in our analysis, but also vaginismus prior to childbirth, for which
18 we did not have information. This could draw the results towards an association between caesarean
19 section and more sexual problems. However, caesarean section on maternal request was rare in
20 Denmark in the 1990s and 2000s – less than 2% of all births.²⁵ Results were unchanged when we only
21 considered women who had their first birth in the Danish National Birth Cohort.
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35 The prevalence of sexual problems in midlife in the present study is broadly within the range from
36 previous reports. In this study, as in previous studies,^{10,12} episiotomies were not associated with more
37 sexual problems. Rather, women with episiotomies reported less deep dyspareunia than women with no
38 tears or first degree tears. Shorter second stages of labour are observed when episiotomy is used,⁵
39 which might explain why these women have less deep dyspareunia. However, at present our results do
40 not justify a change in the advice on avoiding routine use of episiotomy.²⁶ Some previous studies found
41 no association between anal sphincter tears and long-term sexual problems,^{9,12} whereas others found
42 increased risk of dyspareunia¹¹ or reduced lubrication¹⁰ as we did. Scar tissue and a higher prevalence
43 of incontinence might explain this finding, but the underlying reasons for the tear could also play a
44 role.
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2 Previous studies of long-term sexual health between different modes of birth were small.^{10,12} The
3 studies were carried out in the USA and in Switzerland, countries with different obstetric traditions
4 from Denmark, and neither found indication that caesarean section protected against sexual problems in
5 the long term.^{10,12} There are a number of possible explanations for the association between caesarean
6 sections and sexual problems identified in this study. Abdominal adhesions after caesarean section are
7 not likely to be the whole explanation, since this would not explain why women who had delivered by
8 caesarean section also reported more entry dyspareunia, nor why vaginal birth after caesarean section
9 reduces sexual problems. It is possible that expectation of deep dyspareunia can reduce lubrication and
10 heighten the risk of entry dyspareunia. The simplest explanation is that the achievement of at least one
11 vaginal birth is protective against sexual problems in later life. This might be a physical effect if,
12 contrary to anecdote, changes to the perineum after vaginal birth are in some way associated with less
13 pain or greater pleasure. There may also be psychosexual benefits from achieving a vaginal birth.
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24 Caesarean section has been proposed as preventive of pelvic floor dysfunctions, such as pelvic organ
25 prolapse, and urinary and anal incontinence. Caesarean section appears to protect against pelvic organ
26 prolapse in both the short and long term.⁸ For urinary incontinence, there appears to be a protective
27 effect of caesarean section in the short term. However, as women age, this potential effect is no longer
28 found.⁸ The current evidence does not support any protective effect of caesarean section on anal
29 incontinence outside the immediate post-partum period.⁸ These factors should all be taken into account,
30 along with sexual health, when counselling a woman about the choice of mode of birth.
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38 Our findings do not support choosing caesarean section over vaginal birth in order to prevent long-term
39 sexual problems. Instead, vaginal birth appears to be associated with fewer sexual problems, even when
40 it involves instrumental birth, or an episiotomy.
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45 **CONTRIBUTOR AND GUARANTOR INFORMATION**

46 All authors contributed to the design of the study. JO and EAN were responsible for the data collection.
47 SH analysed the data with help from HK. SH, HK, EAN, JGT, and JO interpreted the results. SH wrote
48 the first draft of the manuscript, and EAN, HK, JGT, and JO critically revised it. All authors approved
49 the final manuscript. All authors are guarantors.
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LICENCE FOR PUBLICATION

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DATA SHARING

The data that support the findings of this study are available from the Danish National Birth Cohort but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. Data are however available from the authors upon reasonable request and with permission from the Danish National Birth Cohort and the Danish Data Protection Agency.

TRANSPARENCY

The authors affirm that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

COMPETING INTERESTS

All authors have completed the ICMJE uniform disclosure form at www.icmje.org/coi_disclosure.pdf and declare: no support from any organization for the submitted work; no financial relationships with any organizations that might have an interest in the submitted work in the previous three years; no other relationships or activities that could appear to have influenced the submitted work.

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1
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8 design, data collection, data analysis, data interpretation, or writing of the report. SH and HK had full
9 access to all the data in the study, and all authors had final responsibility for the decision to submit for
10 publication.
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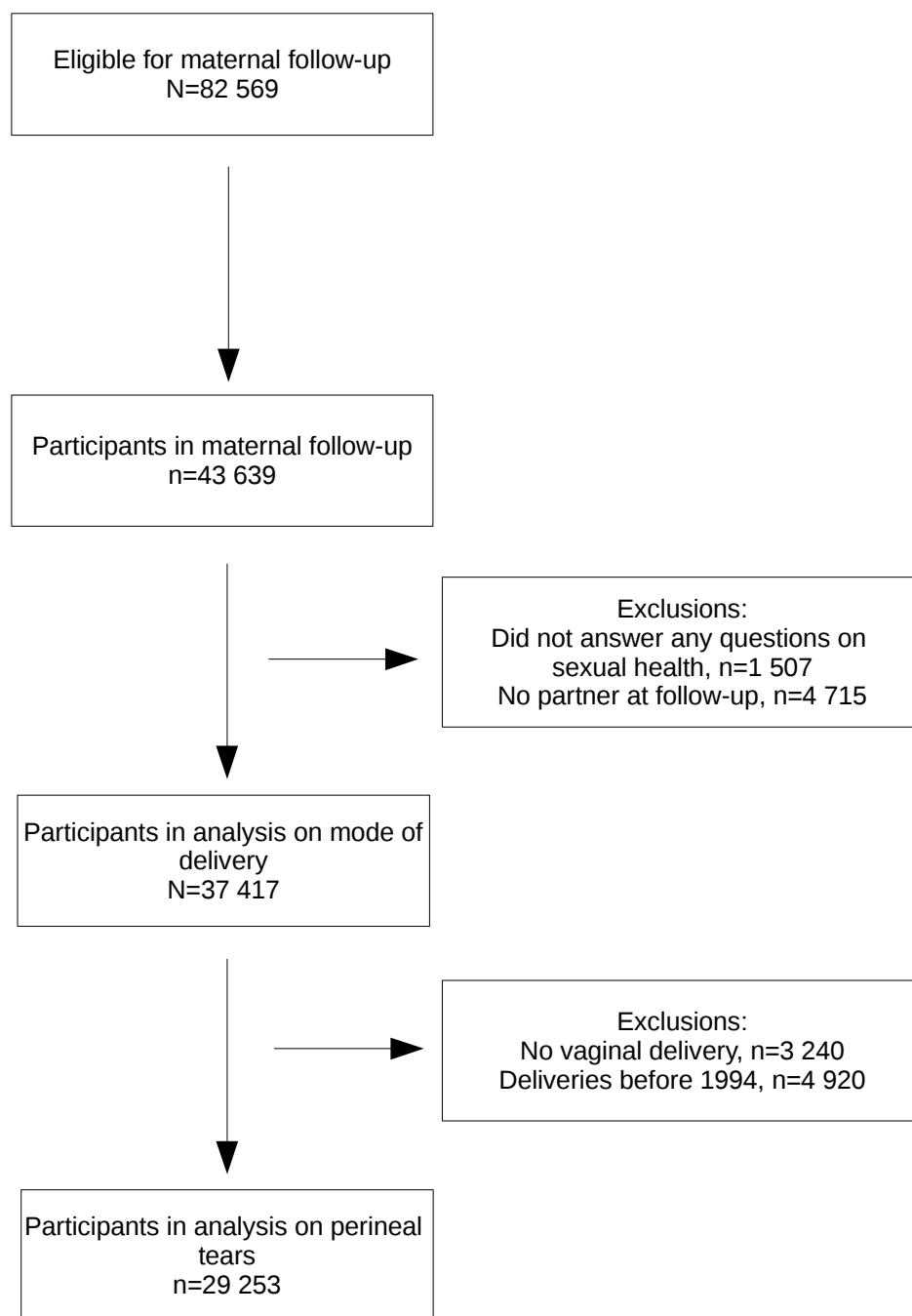
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FIGURE LEGEND

Figure 1: Flow chart of the study population.

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Mode of birth and long term sexual health – follow-up of the Danish National Birth Cohort

Sarah Hjorth, Helene Kirkegaard, Jørn Olsen, Jim G Thornton, Ellen A Nohr

Supplemental material

The supplementary material contains:

Supplemental table 1: Sexual health in the past year (2012-2013) in mothers in their mid-forties (N=37 147).

Supplemental table 2: Sexual problems by degree of perineal tear, 3rd and 4th degree tears analysed separately.

Supplemental table 3: Sexual problems by mode of birth in participants with complete data.

Supplemental table 4: Sexual problems by degree of perineal tear in participants with complete data.

Supplemental table 5: Exposures in participants and non-participants.

Supplemental table 6: Sexual problems by mode of birth in women who had their first birth in the DNBC.

Supplemental table 7: Sexual problems by degree of perineal tear in women who had their first birth in the DNBC.

Supplemental table 8: Frequent dyspareunia by mode of birth.

Supplemental table 9: Sexual problems by mode of birth in participants without vaginismus.

Supplemental table 10: Participant characteristics by degree of perineal tear.

Supplemental table 11: Frequent dyspareunia by degree of perineal tear.

Supplemental figure 1: Directed acyclic graph.

Supplemental table 1: Sexual health in the past year (2012-2013) in mothers in their mid-forties (N=37 147).

	n (%)*
Have your sexual needs been met?	
Completely	15 081 (41)
Almost completely	10 208 (29)
Partially	6 666 (18)
A little	2 248 (6)
Not at all	1 090 (3)
I have not had sexual needs	1 108 (3)
I do not know	290 (1)
How often have you been sexually active with another person?	
Every day	89 (0.2)
3–6 times a week	3 432 (9)
1–2 times a week	13 640 (37)
1–3 times a month	12 671 (35)
Less than once a month	4 960 (14)
Not at all	1 327 (4)
I do not know	348 (1)
Have you experienced lacking or reduced sexual desire?	
Yes, all the time	1 551 (4)
Yes, often	7 551 (21)
Yes, sometimes	13 566 (37)
Yes, but rarely	9 084 (25)
No, never	4 612 (13)
I do not know	376 (1.)
<i>If yes, was it a problem for you?</i>	
Yes	7 945 (35)
No	12 220 (55)
I do not know	2 275 (10)
<i>Was it a problem for your partner?</i>	
Yes	12 752 (61)
No	4 465 (21)
I do not know	3 740 (18)
Have you experienced the following during sexual activity with another person?	

Supplemental table 1: Sexual health in the past year (2012-2013) in mothers in their mid-forties (N=37 147) (continued).

	n (%)*
I have not been sufficiently wet in the vagina	
Not at all	18 242 (51)
Rarely	8 272 (23)
Sometimes	5 938 (16)
Often	2 024 (6)
Every time	885 (2)
I do not know	787 (2)
I have not, or only with great difficulty, achieved orgasm	
Not at all	13 119 (36)
Rarely	10 580 (29)
Sometimes	6 853 (19)
Often	2 943 (8)
Every time	1 707 (5)
I do not know	817 (2)
I have had vaginismus that prevented intercourse	
Not at all	34 601 (95)
Rarely	638 (2)
Sometimes	269 (1)
Often	87 (0.2)
Every time	16 (<0.1)
I do not know	647 (2)
I have had pain in my genitals and/or abdomen with intercourse	
Not at all	26 965 (74)
Rarely	5 256 (14)
Sometimes	2 704 (7)
Often	584 (2)
Every time	211 (1)
I do not know	546 (2)
If yes, where was the pain located?†	
At the vaginal entrance	1 253 (36)
Deep in the abdomen	2 277 (65)
I do not know	228 (7)

*Percentage of those who have answered the question. The number of answers available for analysis for each outcome differed, as the response option 'I do not wish to answer this question' was provided for questions on sexual health and varied for all questions between 210

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2 and 1361. The number of missing values were between 0 and 37 for all questions except 'was it a problem for your partner?' with 1503
3 missing values.

4 †More than one answer could be given, wherefore the percentage adds up to more than 100.
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Supplemental table 2: Sexual problems by degree of perineal tear, 3rd and 4th degree tears analysed separately.

	No tear/first degree	Second degree	Episiotomy	Third degree	Fourth degree
One or more sexual problem(s), n=27 992					
Cases (%)	5 882 (37)	1 560 (38)	2 278 (36)	617 (38)	99 (42)
Crude OR (95% CI)	Reference	1.04 (0.97–1.12)	0.95 (0.90–1.01)	1.01 (0.91–1.12)	1.19 (0.92–1.55)
Adjusted OR* (95% CI)	Reference	1.03 (0.96–1.11)	0.95 (0.90–1.01)	1.00 (0.90–1.11)	1.17 (0.90–1.52)
Reduced sexual desire, n=28 586					
Cases (%)	3 523 (22)	935 (22)	1 342 (21)	369 (22)	54 (22)
Crude OR (95% CI)	Reference	1.02 (0.94–1.11)	0.94 (0.87–1.00)	1.01 (0.89–1.14)	1.00 (0.74–1.36)
Adjusted OR* (95% CI)	Reference	1.01 (0.93–1.10)	0.95 (0.88–1.01)	1.00 (0.88–1.13)	0.99 (0.73–1.34)
Difficulty in obtaining orgasm, n=28 217					
Cases (%)	2 006 (13)	553 (13)	817 (13)	232 (14)	29 (12)
Crude OR (95% CI)	Reference	1.08 (0.97–1.19)	1.02 (0.93–1.11)	1.13 (0.98–1.31)	0.94 (0.64–1.39)
Adjusted OR* (95% CI)	Reference	1.07 (0.96–1.18)	1.01 (0.93–1.11)	1.12 (0.96–1.29)	0.92 (0.62–1.36)
Insufficient lubrication, n=28 308					
Cases (%)	1 133 (7)	314 (8)	481 (8)	139 (8)	24 (10)
Crude OR (95% CI)	Reference	1.08 (0.95–1.23)	1.06 (0.95–1.19)	1.19 (0.99–1.43)	1.43 (0.93–2.19)
Adjusted OR* (95% CI)	Reference	1.09 (0.96–1.25)	1.02 (0.91–1.14)	1.17 (0.97–1.41)	1.42 (0.93–1.19)
Dyspareunia, n=28 398					
Cases (%)	1 469 (9)	372 (9)	562 (9)	158 (10)	26 (11)
Crude OR (95% CI)	Reference	0.98 (0.87–1.10)	0.95 (0.86–1.05)	1.04 (0.87–1.23)	1.18 (0.78–1.77)
Adjusted OR* (95% CI)	Reference	0.97 (0.86–1.10)	0.96 (0.87–1.07)	1.05 (0.88–1.25)	1.17 (0.77–1.77)
Entry dyspareunia, n=28 006					
Cases (%)	453 (3)	115 (3)	201 (3)	62 (4)	12 (5)
Crude OR (95% CI)	Reference	0.98 (0.80–1.21)	1.11 (0.94–1.31)	1.33 (1.01–1.74)	1.77 (0.98–3.19)
Adjusted OR* (95% CI)	Reference	0.98 (0.79–1.20)	1.09 (0.92–1.30)	1.29 (0.98–1.69)	1.74 (0.97–3.15)
Deep dyspareunia, n=28 006					
Cases (%)	1 035 (7)	265 (7)	355 (6)	103 (6)	14 (6)
Crude OR (95% CI)	Reference	0.99 (0.86–1.14)	0.85 (0.75–0.96)	0.95 (0.77–1.18)	0.88 (0.51–1.51)
Adjusted OR* (95% CI)	Reference	0.98 (0.85–1.13)	0.87 (0.77–0.99)	0.99 (0.80–1.22)	0.88 (0.51–1.51)

*Adjusted for maternal age at first birth, calendar year at first birth, pre-pregnant body mass index, socio-occupational status, self-assessed health, disease, exercise in pregnancy, and smoking in pregnancy.

CI: Confidence interval; OR: Odds ratio.

Supplemental table 3: Sexual problems by mode of birth in participants with complete data.

	Only spontaneous births	Instrumental vaginal birth, ever	Only c-sections	Spontaneous VBAC	Instrumental VBAC	C-section after vaginal birth
One or more sexual problem(s), n=32 638						
Cases (%)	7 615 (37)	1 643 (38)	1 144 (42)	651 (37)	177 (44)	1 043 (39)
Crude OR (95% CI)	Reference	1.03 (0.96–1.10)	1.21 (1.12–1.32)	1.00 (0.90–1.10)	1.34 (1.10–1.64)	1.10 (1.01–1.20)
Adjusted OR* (95% CI)	Reference	1.02 (0.95–1.09)	1.16 (1.07–1.26)	1.00 (0.90–1.10)	1.34 (1.10–1.64)	1.09 (1.00–1.18)
Reduced desire, n=33 360						
Cases (%)	4 547 (22)	956 (21)	644 (23)	395 (22)	100 (24)	602 (22)
Crude OR (95% CI)	Reference	0.99 (0.92–1.07)	1.07 (0.97–1.17)	1.02 (0.91–1.14)	1.17 (0.93–1.47)	1.03 (0.94–1.14)
Adjusted OR* (95% CI)	Reference	0.99 (0.92–1.07)	1.03 (0.94–1.13)	1.02 (0.91–1.14)	1.17 (0.93–1.47)	1.02 (0.93–1.13)
Difficulty in obtaining orgasm, n=32 915						
Cases (%)	2 621 (13)	590 (13)	377 (14)	233 (13)	69 (17)	361 (13)
Crude OR (95% CI)	Reference	1.07 (0.97–1.18)	1.08 (0.96–1.22)	1.04 (0.90–1.20)	1.43 (1.10–1.85)	1.08 (0.96–1.21)
Adjusted OR* (95% CI)	Reference	1.06 (0.96–1.16)	1.03 (0.92–1.16)	1.04 (0.90–1.20)	1.42 (1.09–1.84)	1.07 (0.95–1.21)
Insufficient lubrication, n=33 033						
Cases (%)	1 551 (7)	351 (8)	310 (11)	126 (7)	39 (10)	272 (10)
Crude OR (95% CI)	Reference	1.07 (0.95–1.21)	1.55 (1.36–1.76)	0.94 (0.79–1.13)	1.31 (0.94–1.83)	1.40 (1.22–1.60)
Adjusted OR* (95% CI)	Reference	1.00 (0.89–1.13)	1.40 (1.23–1.60)	0.95 (0.79–1.14)	1.23 (0.88–1.72)	1.35 (1.18–1.55)
Dyspareunia, n=33 140						
Cases (%)	1 858 (9)	407 (9)	417 (15)	164 (9)	48 (12)	282 (10)
Crude OR (95% CI)	Reference	1.03 (0.92–1.16)	1.79 (1.60–2.00)	1.03 (0.87–1.21)	1.36 (1.00–1.84)	1.19 (1.05–1.36)
Adjusted OR* (95% CI)	Reference	1.05 (0.93–1.17)	1.76 (1.57–1.98)	1.04 (0.88–1.23)	1.39 (1.02–1.89)	1.16 (1.02–1.33)
Entry dyspareunia, n=32 645						
Cases (%)	573 (3)	148 (3)	219 (8)	67 (4)	21 (5)	101 (4)
Crude OR (95% CI)	Reference	1.23 (1.02–1.48)	3.04 (2.59–3.57)	1.37 (1.06–1.77)	1.93 (1.24–3.02)	1.38 (1.11–1.71)
Adjusted OR* (95% CI)	Reference	1.19 (0.99–1.43)	2.81 (2.38–3.32)	1.37 (1.06–1.77)	1.89 (1.20–2.95)	1.36 (1.09–1.68)
Deep dyspareunia, n=32 645						
Cases (%)	1 308 (6)	253 (6)	206 (8)	96 (5)	29 (7)	182 (7)
Crude OR (95% CI)	Reference	0.91 (0.79–1.04)	1.20 (1.03–1.40)	0.84 (0.68–1.04)	1.15 (0.79–1.69)	1.08 (0.92–1.27)
Adjusted OR* (95% CI)	Reference	0.94 (0.82–1.09)	1.21 (1.04–1.42)	0.85 (0.69–1.06)	1.21 (0.82–1.77)	1.05 (0.89–1.24)

*Adjusted for maternal age at first birth, calendar year at first birth, pre-pregnant body mass index, socio-occupational status, self-assessed health, disease, exercise in pregnancy, and smoking in pregnancy.

C-section: Caesarean section; CI: Confidence interval; OR: Odds ratio; VBAC: Vaginal birth after caesarean section.

Supplemental table 4: Sexual problems by degree of perineal tear in participants with complete data.

	No tear/first degree	Second degree	Episiotomy	Anal sphincter tear
One or more sexual problem(s), n=25 655				
Cases (%)	5 434 (37)	1 430 (38)	2 086 (36)	644 (37)
Crude OR (95% CI)	Reference	1.04 (0.96–1.12)	0.95 (0.89–1.01)	1.00 (0.90–1.10)
Adjusted OR* (95% CI)	Reference	1.03 (0.95–1.11)	0.95 (0.89–1.02)	0.98 (0.89–1.09)
Reduced sexual desire, n=26 194				
Cases (%)	3 247 (22)	859 (23)	1 228 (21)	382 (22)
Crude OR (95% CI)	Reference	1.03 (0.94–1.12)	0.94 (0.87–1.01)	0.99 (0.88–1.11)
Adjusted OR* (95% CI)	Reference	1.01 (0.93–1.11)	0.95 (0.88–1.02)	0.98 (0.87–1.10)
Difficulty in obtaining orgasm, n=25 861				
Cases (%)	1 852 (13)	512 (14)	749 (13)	244 (14)
Crude OR (95% CI)	Reference	1.09 (0.98–1.21)	1.02 (0.93–1.12)	1.13 (0.98–1.30)
Adjusted OR* (95% CI)	Reference	1.07 (0.96–1.19)	1.02 (0.93–1.11)	1.11 (0.96–1.28)
Insufficient lubrication, n=25 945				
Cases (%)	1 051 (7)	286 (8)	437 (8)	146 (8)
Crude OR (95% CI)	Reference	1.06 (0.93–1.22)	1.05 (0.93–1.18)	1.18 (0.99–1.42)
Adjusted OR* (95% CI)	Reference	1.08 (0.94–1.24)	1.00 (0.89–1.12)	1.16 (0.97–1.40)
Dyspareunia, n=26 028				
Cases (%)	1 348 (9)	340 (9)	519 (9)	160 (9)
Crude OR (95% CI)	Reference	0.98 (0.86–1.11)	0.96 (0.87–1.07)	1.00 (0.84–1.18)
Adjusted OR* (95% CI)	Reference	0.98 (0.86–1.11)	0.98 (0.88–1.09)	1.01 (0.85–1.20)
Entry dyspareunia, n=25 670				
Cases (%)	415 (3)	103 (3)	187 (3)	65 (4)
Crude OR (95% CI)	Reference	0.97 (0.78–1.20)	1.14 (0.96–1.36)	1.33 (1.02–1.74)
Adjusted OR* (95% CI)	Reference	0.97 (0.78–1.21)	1.12 (0.94–1.34)	1.31 (1.00–1.71)
Deep dyspareunia, n=25 670				
Cases (%)	954 (7)	245 (7)	326 (6)	101 (6)
Crude OR (95% CI)	Reference	1.00 (0.87–1.16)	0.85 (0.75–0.97)	0.89 (0.72–1.09)
Adjusted OR* (95% CI)	Reference	1.00 (0.86–1.15)	0.88 (0.77–1.00)	0.91 (0.74–1.13)

*Adjusted for maternal age at first birth, calendar year at first birth, pre-pregnant body mass index, socio-occupational status, self-assessed health, disease, exercise in pregnancy, and smoking in pregnancy.

CI: Confidence interval; OR: Odds ratio.

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2 **Supplemental table 5: Exposures in participants and non-participants.**
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	The DNBC*	The maternal follow-up	Participants in This study	One or more sexual problems†
Mode of birth, n (%)				
All	88 128	43 639	37 417	35 514
Only spontaneous births	54 728 (62)	27 440 (63)	23 608 (63)	22 496 (63)
Instrumental vaginal birth, ever	11 521 (13)	5 845 (13)	5 003 (13)	4 736 (13)
Only c-sections	8 386 (10)	3 895 (9)	3 244 (9)	3 014 (9)
Spontaneous VBAC	4 565 (5)	2 355 (5)	2 038 (5)	1 931 (5)
Instrumental VBAC	1 080 (1)	526 (1)	457 (1)	431 (1)
C-section after vaginal birth	7 848 (9)	3 578 (8)	3 067 (8)	2 906 (8)
Degree of perineal tear, n (%)‡				
All	67 516	33 889	29 253	27 864
No tear or first degree	38 625 (57)	19 094 (56)	16 404 (56)	15 682 (56)
Second degree	9 590 (14)	4 888 (14)	4 267 (15)	4 047 (15)
Episiotomy	15 025 (22)	7 662 (23)	6 615 (22.6)	6 274 (23)
Anal sphincter tear	4 276 (6)	2 245 (7)	1 967 (7)	1 861 (7)

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16 *Women with a live- or stillbirth in the DNBC.

17 †The outcome with highest percentage of missing data.

18 ‡Women with a vaginal birth and no birth prior to 1994.

19 C-section: Caesarean section; DNBC: Danish National Birth Cohort; VBAC: Vaginal birth after caesarean section.
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Supplemental table 6: Sexual problems by mode of birth in women who had their first birth in the DNBC.

	Only spontaneous births	Instrumental vaginal birth, ever	Only c-sections	Spontaneous VBAC	Instrumental VBAC	C-section after vaginal birth
One or more sexual problem(s), n=17 587						
Cases (%)	4 069 (38)	920 (39)	865 (41)	342 (39)	90 (46)	517 (40)
Crude OR (95% CI)	Reference	1.07 (0.98–1.18)	1.17 (1.06–1.28)	1.04 (0.90–1.19)	1.43 (1.08–1.90)	1.10 (0.98–1.24)
Adjusted OR* (95% CI)	Reference	1.07 (0.98–1.18)	1.15 (1.04–1.27)	1.04 (0.90–1.20)	1.43 (1.08–1.91)	1.09 (0.97–1.23)
Reduced desire, n=17 941						
Cases (%)	2 466 (22)	541 (23)	500 (23)	211 (23)	52 (26)	295 (22)
Crude OR (95% CI)	Reference	1.02 (0.92–1.13)	1.05 (0.94–1.17)	1.05 (0.90–1.24)	1.22 (0.89–1.68)	1.00 (0.87–1.15)
Adjusted OR* (95% CI)	Reference	1.02 (0.92–1.14)	1.04 (0.93–1.17)	1.06 (0.90–1.24)	1.22 (0.89–1.68)	0.98 (0.86–1.13)
Difficulty in obtaining orgasm, n=17 730						
Cases (%)	1 397 (13)	332 (14)	285 (13)	131 (15)	33 (17)	176 (14)
Crude OR (95% CI)	Reference	1.11 (0.98–1.27)	1.05 (0.92–1.21)	1.16 (0.96–1.41)	1.37 (0.94–2.00)	1.06 (0.90–1.26)
Adjusted OR* (95% CI)	Reference	1.11 (0.97–1.26)	1.04 (0.91–1.20)	1.16 (0.96–1.41)	1.38 (0.94–2.01)	1.06 (0.89–1.25)
Insufficient lubrication, n=17 784						
Cases (%)	738 (7)	173 (7)	220 (10)	55 (6)	21 (11)	124 (10)
Crude OR (95% CI)	Reference	1.09 (0.92–1.29)	1.59 (1.35–1.86)	0.90 (0.68–1.19)	1.65 (1.04–2.61)	1.44 (1.18–1.76)
Adjusted OR* (95% CI)	Reference	1.03 (0.87–1.23)	1.38 (1.17–1.62)	0.91 (0.68–1.20)	1.64 (1.03–2.60)	1.45 (1.19–1.77)
Dyspareunia, n=17 840						
Cases (%)	995 (9)	230 (10)	312 (15)	82 (9)	28 (14)	157 (12)
Crude OR (95% CI)	Reference	1.07 (0.92–1.25)	1.71 (1.49–1.96)	1.00 (0.79–1.27)	1.65 (1.10–2.48)	1.35 (1.13–1.62)
Adjusted OR* (95% CI)	Reference	1.09 (0.93–1.26)	1.69 (1.47–1.94)	1.00 (0.79–1.27)	1.68 (1.12–2.53)	1.31 (1.09–1.57)
Entry dyspareunia, n=17 573						
Cases (%)	300 (3)	80 (3)	158 (8)	33 (4)	11 (6)	54 (4)
Crude OR (95% CI)	Reference	1.24 (0.97–1.60)	2.87 (2.36–3.51)	1.35 (0.93–1.94)	2.09 (1.13–3.88)	1.52 (1.13–2.04)
Adjusted OR* (95% CI)	Reference	1.20 (0.93–1.54)	2.56 (2.08–3.14)	1.35 (0.93–1.95)	2.06 (1.11–3.83)	1.52 (1.13–2.04)
Deep dyspareunia, n=17 573						
Cases (%)	721 (7)	151 (6)	160 (8)	50 (6)	18 (9)	182 (8)
Crude OR (95% CI)	Reference	0.97 (0.81–1.16)	1.16 (0.97–1.39)	0.83 (0.62–1.12)	1.42 (0.87–2.32)	1.27 (1.03–1.57)
Adjusted OR* (95% CI)	Reference	1.00 (0.83–1.20)	1.21 (1.01–1.45)	0.84 (0.62–1.12)	1.48 (0.90–2.42)	1.21 (0.98–1.50)

*Adjusted for maternal age at first birth, calendar year at first birth, pre-pregnant body mass index, socio-occupational status, self-assessed health, disease, exercise in pregnancy, and smoking in pregnancy.
 C-section: Caesarean section; CI: Confidence interval; DNBC: Danish National Birth Cohort; OR: Odds ratio; VBAC: Vaginal birth after caesarean section.

Supplemental table 7: Sexual problems by degree of perineal tear in women who had their first birth in the DNBC.

	No tear/first degree	Second degree	Episiotomy	Anal sphincter tear
One or more sexual problem(s), n=15 496				
Cases (%)	3 251 (38)	1 087 (39)	1 120 (37)	480 (39)
Crude OR (95% CI)	Reference	1.03 (0.95–1.13)	0.94 (0.87–1.03)	1.01 (0.90–1.14)
Adjusted OR* (95% CI)	Reference	1.04 (0.95–1.13)	0.94 (0.86–1.02)	1.02 (0.90–1.15)
Reduced sexual desire, n=15 794				
Cases (%)	1 971 (23)	650 (23)	655 (21)	289 (23)
Crude OR (95% CI)	Reference	0.99 (0.90–1.10)	0.91 (0.82–1.00)	1.00 (0.87–1.15)
Adjusted OR* (95% CI)	Reference	1.00 (0.90–1.11)	0.91 (0.82–1.01)	1.01 (0.88–1.16)
Difficulty in obtaining orgasm, n=15 610				
Cases (%)	1 108 (13)	386 (14)	402 (13)	173 (14)
Crude OR (95% CI)	Reference	1.07 (0.95–1.22)	1.01 (0.90–1.15)	1.08 (0.91–1.28)
Adjusted OR* (95% CI)	Reference	1.07 (0.95–1.21)	1.01 (0.89–1.14)	1.08 (0.91–1.28)
Insufficient lubrication, n=15 656				
Cases (%)	572 (7)	208 (7)	224 (7)	107 (9)
Crude OR (95% CI)	Reference	1.12 (0.95–1.32)	1.10 (0.94–1.29)	1.31 (1.05–1.62)
Adjusted OR* (95% CI)	Reference	1.11 (0.94–1.31)	1.07 (0.91–1.25)	1.27 (1.03–1.58)
Dyspareunia, n=15 705				
Cases (%)	834 (10)	261 (9)	269 (9)	128 (10)
Crude OR (95% CI)	Reference	0.94 (0.82–1.09)	0.89 (0.77–1.03)	1.05 (0.87–1.28)
Adjusted OR* (95% CI)	Reference	0.95 (0.82–1.10)	0.89 (0.77–1.03)	1.08 (0.89–1.32)
Entry dyspareunia, n=15 494				
Cases (%)	247 (3)	78 (3)	102 (3)	51 (4)
Crude OR (95% CI)	Reference	0.96 (0.74–1.24)	1.16 (0.92–1.46)	1.43 (1.04–1.94)
Adjusted OR* (95% CI)	Reference	0.95 (0.73–1.23)	1.13 (0.90–1.43)	1.41 (1.03–1.92)
Deep dyspareunia, n=15 494				
Cases (%)	603 (7)	191 (7)	172 (6)	82 (7)
Crude OR (95% CI)	Reference	0.96 (0.81–1.14)	0.78 (0.66–0.93)	0.92 (0.73–1.17)
Adjusted OR* (95% CI)	Reference	0.97 (0.82–1.15)	0.79 (0.66–0.94)	0.97 (0.76–1.22)

*Adjusted for maternal age at first birth, calendar year at first birth, pre-pregnant body mass index, socio-occupational status, self-assessed health, disease, exercise in pregnancy, and smoking in pregnancy.

CI: Confidence interval; DNBC: Danish National Birth Cohort; OR: Odds ratio.

Supplemental table 8: Frequent dyspareunia by mode of birth.

	Only spontaneous births	Instrumental vaginal birth, ever	Only c-sections	Spontaneous VBAC	Instrumental VBAC	C-section after vaginal birth
Dyspareunia, n=36 266						
Cases (%)	415 (2)	97 (2)	166 (5)	30 (3)	13 (3)	74 (3)
Crude OR (95% CI)	Reference	1.10 (0.88–1.38)	3.06 (2.54–3.68)	0.84 (0.57–1.21)	1.63 (0.93–2.85)	1.39 (1.08–1.78)
Adjusted OR* (95% CI)	Reference	1.09 (0.87–1.36)	2.82 (2.32–3.41)	0.83 (0.57–1.21)	1.59 (0.90–2.78)	1.32 (1.02–1.69)
Entry dyspareunia, n=35 720						
Cases (%)	181 (1)	42 (1)	106 (4)	15 (1)	8 (2)	32 (1)
Crude OR (95% CI)	Reference	1.10 (0.78–1.54)	4.49 (2.36–3.51)	0.96 (0.57–1.63)	2.32 (1.13–4.73)	1.37 (0.94–2.00)
Adjusted OR* (95% CI)	Reference	1.02 (0.73–1.43)	3.92 (3.03–5.05)	0.95 (0.56–1.61)	2.17 (1.06–4.45)	1.32 (0.90–1.93)
Deep dyspareunia, n=35 720						
Cases (%)	263 (1)	63 (1)	73 (2)	18 (1)	8 (2)	44 (2)
Crude OR (95% CI)	Reference	1.14 (0.86–1.50)	2.10 (1.61–2.72)	0.79 (0.49–1.28)	1.58 (0.78–3.23)	1.30 (0.94–1.79)
Adjusted OR* (95% CI)	Reference	1.17 (0.89–1.55)	2.01 (1.53–2.64)	0.79 (0.49–1.28)	1.60 (0.78–3.27)	1.21 (0.88–1.67)

*Adjusted for maternal age at first birth, calendar year at first birth, pre-pregnant body mass index, socio-occupational status, self-assessed health, disease, exercise in pregnancy, and smoking in pregnancy.

C-section: Caesarean section; CI: Confidence interval; OR: Odds ratio; VBAC: Vaginal birth after caesarean section.

Supplemental table 9: Sexual problems by mode of birth in participants without vaginismus.

	Only spontaneous births	Instrumental vaginal birth, ever	Only c-sections	Spontaneous VBAC	Instrumental VBAC	C-section after vaginal birth
One or more sexual problem(s), n=35 343						
Cases (%)	8 196 (37)	1 759 (37)	1 229 (41)	705 (37)	185 (43)	1 119 (39)
Crude OR (95% CI)	Reference	1.02 (0.96–1.09)	1.21 (1.12–1.31)	1.00 (0.91–1.11)	1.33 (1.10–1.61)	1.10 (1.02–1.20)
Adjusted OR* (95% CI)	Reference	1.02 (0.95–1.08)	1.17 (1.08–1.27)	1.00 (0.91–1.11)	1.33 (1.09–1.61)	1.09 (1.01–1.18)
Reduced desire, n=36 139						
Cases (%)	4 917 (22)	1 034 (21)	702 (23)	431 (22)	103 (24)	639 (22)
Crude OR (95% CI)	Reference	0.99 (0.92–1.07)	1.08 (0.99–1.18)	1.03 (0.93–1.15)	1.13 (0.90–1.41)	1.02 (0.93–1.11)
Adjusted OR* (95% CI)	Reference	0.99 (0.92–1.07)	1.04 (0.95–1.14)	1.03 (0.92–1.15)	1.13 (0.90–1.41)	1.00 (0.91–1.10)
Difficulty in obtaining orgasm, n=35 650						
Cases (%)	2 822 (13)	631 (13)	406 (13)	252 (13)	71 (17)	390 (13)
Crude OR (95% CI)	Reference	1.06 (0.97–1.16)	1.08 (0.97–1.21)	1.04 (0.91–1.20)	1.39 (1.07–1.80)	1.09 (0.97–1.22)
Adjusted OR* (95% CI)	Reference	1.05 (0.96–1.16)	1.05 (0.94–1.18)	1.04 (0.91–1.20)	1.38 (1.07–1.79)	1.08 (0.97–1.21)
Insufficient lubrication, n=35 777						
Cases (%)	1 663 (7)	370 (8)	318 (11)	131 (7)	42 (10)	290 (10)
Crude OR (95% CI)	Reference	1.05 (0.94–1.18)	1.48 (1.30–1.67)	0.91 (0.76–1.09)	1.35 (0.98–1.87)	1.39 (1.22–1.59)
Adjusted OR* (95% CI)	Reference	0.99 (0.88–1.12)	1.36 (1.19–1.55)	0.89 (0.74–1.08)	1.28 (0.92–1.77)	1.35 (1.18–1.54)
Dyspareunia, n=35 894						
Cases (%)	1 958 (9)	431 (9)	432 (14)	160 (8)	51 (12)	301 (10)
Crude OR (95% CI)	Reference	1.04 (0.93–1.16)	1.75 (1.56–1.96)	0.94 (0.80–1.12)	1.40 (1.04–1.89)	1.22 (1.07–1.38)
Adjusted OR* (95% CI)	Reference	1.06 (0.95–1.18)	1.73 (1.54–1.94)	0.95 (0.80–1.12)	1.42 (1.06–1.92)	1.18 (1.04–1.35)
Entry dyspareunia, n=35 352						
Cases (%)	613 (3)	153 (3)	223 (8)	60 (3)	21 (5)	109 (4)
Crude OR (95% CI)	Reference	1.19 (0.99–1.42)	2.88 (2.46–3.38)	1.14 (0.87–1.49)	1.84 (1.18–2.88)	1.40 (1.13–1.72)
Adjusted OR* (95% CI)	Reference	1.15 (0.96–1.37)	2.71 (2.30–3.19)	1.14 (0.87–1.49)	1.80 (1.15–2.82)	1.38 (1.12–1.70)
Deep dyspareunia, n=35 352						
Cases (%)	1 367 (6)	269 (6)	222 (8)	98 (5)	32 (8)	195 (7)
Crude OR (95% CI)	Reference	0.93 (0.81–1.06)	1.24 (1.07–1.44)	0.82 (0.66–1.01)	1.25 (0.87–1.80)	1.12 (0.96–1.30)
Adjusted OR* (95% CI)	Reference	0.96 (0.84–1.10)	1.25 (1.07–1.45)	0.83 (0.67–1.03)	1.29 (0.90–1.87)	1.08 (0.93–1.27)

*Adjusted for maternal age at first birth, calendar year at first birth, pre-pregnant body mass index, socio-occupational status, self-assessed health, disease, exercise in pregnancy, and smoking in pregnancy.

C-section: Caesarean section; CI: Confidence interval; OR: Odds ratio; VBAC: Vaginal birth after caesarean section.

1
2 **Supplemental table 10: Participant Characteristics by Degree of Perineal Tear.**
3

4

	Degree of perineal tear				
	All (n=29 253)	None or first (n=16 404)	Second (n=4 267)	Episiotomy (n=6 615)	Anal sphincter (n=1 967)
Age at first birth, n (%)					
<25	4 522 (15)	2 763 (17)	563 (13)	993 (15)	203 (10)
25–29	16 073 (55)	9 010 (55)	2 394 (56)	3 566 (54)	1 103 (56)
30–34	7 269 (25)	3 926 (24)	1 085 (25)	1 716 (26)	542 (28)
≥35	1 389 (5)	705 (4)	225 (5)	340 (5)	119 (6)
Socio-occupational status, n (%)*					
Low	1 623 (6)	939 (6)	227 (6)	367 (6)	90 (5)
Middle	9 094 (33)	5 065 (33)	1 367 (34)	2 081 (34)	581 (31)
High	16 804 (61)	9 459 (61)	2 421 (60)	3 748 (60)	1 176 (64)
Missing	1 732	941	252	419	120
Prepregnant BMI, n (%)*					
<18.5	1 169 (4)	661 (4)	120 (3)	320 (5)	68 (4)
18.5–24.9	19 579 (72)	11 142 (73)	2 731 (69)	4 401 (72)	1 305 (72)
25.0–29.9	4 801 (18)	2 573 (17)	823 (21)	1 066 (17)	339 (19)
≥30.0	1 654 (6)	923 (6)	280 (7)	340 (6)	111 (6)
Missing	2 050	1 105	313	488	144
Exercise in pregnancy, min/week, n (%)*					
None	16 147 (57)	8 981 (58)	2 345 (58)	3 735 (60)	1 086 (59)
1–180	9 112 (33)	5 120 (33)	1 372 (34)	2 008 (32)	612 (33)
>180	2 289 (8)	1 382 (9)	301 (7)	458 (7)	148 (8)
Missing	1 705	921	249	414	121
Smoking in pregnancy, n (%)*					
No smoking	22 390 (81)	12 437 (80)	3 304 (81)	5 096 (81)	1 553 (83)
Smoking cessation	2 461 (9)	1 415 (9)	395 (10)	488 (8)	163 (9)
Smoking	2 930 (11)	1 749 (11)	360 (9)	674 (11)	147 (8)

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Supplemental table 10: Participant characteristics by degree of perineal tear (continued).

	Degree of perineal tear				
	All (n=29 253)	None or first (n=16 404)	Second (n=4 267)	Episiotomy (n=6 615)	Anal sphincter (n=1 967)
Missing	1 472	803	208	357	104
Self-assessed health, n (%)*					
Very good	15 564 (56)	8 814 (57)	2 265 (56)	3 472 (56)	1 013 (54)
Normal	11 408 (41)	6 357 (41)	1 677 (42)	2 569 (41)	805 (43)
Not so good	695 (3)	361 (2)	98 (2)	190 (3)	46 (2)
Missing	1 586	872	227	384	103
Presence of disease, n (%)*†					
No	16 450 (60)	9 049 (58)	2 511 (62)	3 713 (60)	1 177 (63)
Yes	11 109 (40)	6 428 (42)	1 518 (38)	2 484 (40)	679 (37)
Missing	1 694	927	238	418	111

*Percentage of non-missing values.

†Diseases that, according to the women, had been confirmed by a physician, including hypertensive disorders, diseases of the heart, thyroid, or musculoskeletal system, epilepsy, diabetes, gynaecological diseases, and mental illness.

BMI: Body mass index.

1
2 **Supplemental table 11: Frequent dyspareunia by degree of perineal tear.**

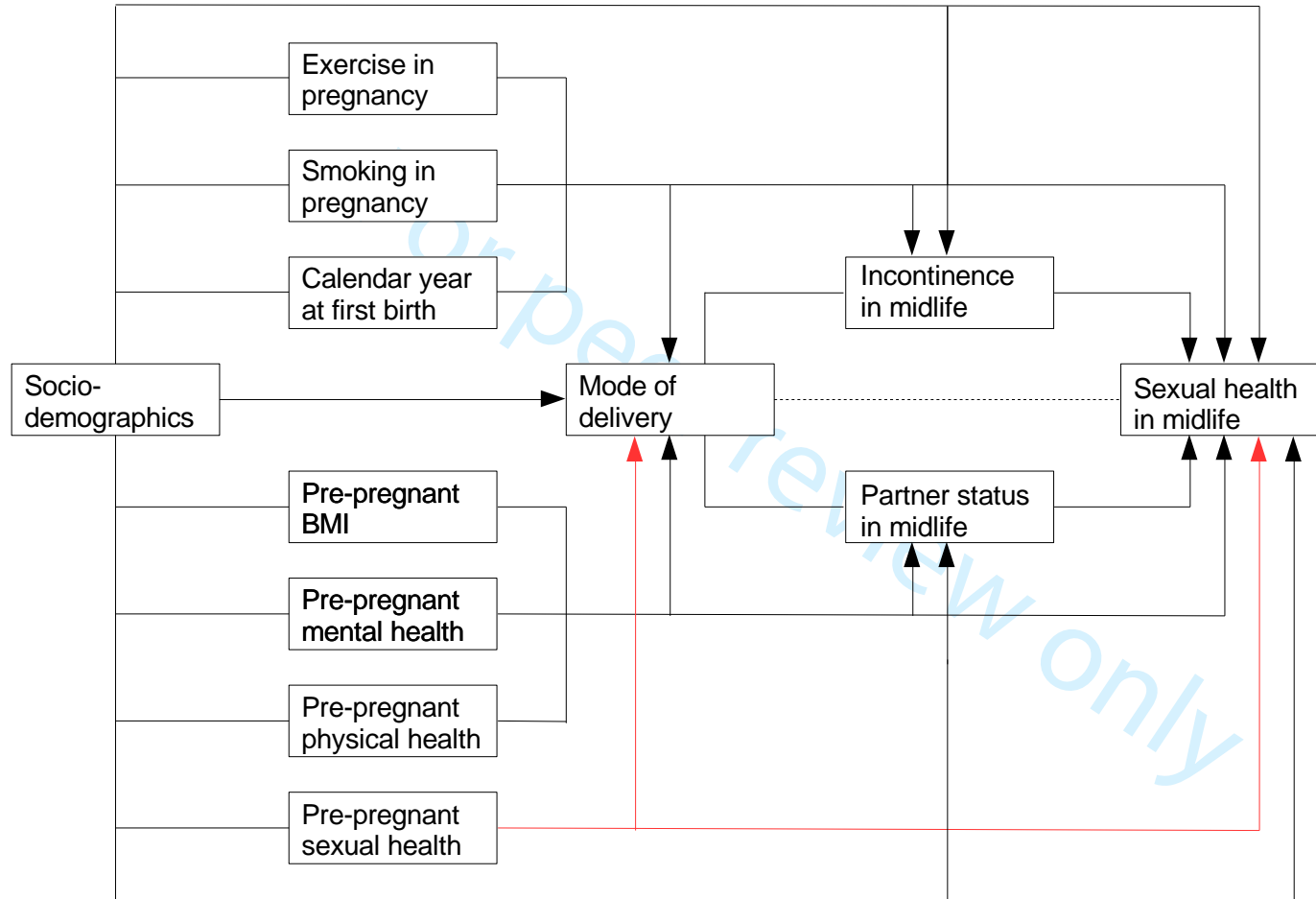
3

	No tear/first degree	Second degree	Episiotomy	Anal sphincter tear
4 Dyspareunia, n=28 398				
5 Cases (%)	296 (2)	80 (2)	116 (2)	37 (2)
6 Crude OR (95% CI)	Reference	1.04 (0.81–1.34)	0.98 (0.78–1.21)	1.05 (0.74–1.48)
7 Adjusted OR* (95% CI)	Reference	1.04 (0.81–1.34)	0.99 (0.80–1.23)	1.06 (0.75–1.50)
8 Entry dyspareunia, n=28 006				
9 Cases (%)	122 (1)	32 (1)	53 (1)	20 (1)
10 Crude OR (95% CI)	Reference	1.02 (0.69–1.50)	1.09 (0.78–1.50)	1.38 (0.86–2.22)
11 Adjusted OR* (95% CI)	Reference	1.01 (0.68–1.50)	1.05 (0.76–1.46)	1.32 (0.82–2.13)
12 Deep dyspareunia, n=28 006				
13 Cases (%)	199 (1)	55 (1)	67 (1)	24 (1)
14 Crude OR (95% CI)	Reference	1.07 (0.79–1.45)	0.84 (0.63–1.11)	1.01 (0.66–1.55)
15 Adjusted OR* (95% CI)	Reference	1.08 (0.80–1.47)	0.87 (0.66–1.15)	1.09 (0.71–1.67)

16 *Adjusted for maternal age at first birth, calendar year at first birth, pre-pregnant body mass index, socio-occupational status, self-assessed health, disease, exercise in pregnancy, and
17 smoking in pregnancy.

18 CI: Confidence interval; OR: Odds ratio.

Supplemental figure 1: Directed acyclic graph



The red arrows represent unadjusted confounding from pre-pregnant sexual health. The dotted line represents the study question. BMI: Body mass index.

We are most grateful to all three reviewers for helping us improve our manuscript. Below we explain how we have responded to each of their comments.

Reviewer: 1

Thank you for the invitation to review this well-written manuscript in which the authors describe in much detail how the data in this large cohort study were collected and analysed. The topic is of interest for the readership of this journal. I doubt, however, if the conclusions can be drawn as firmly as the authors do. The clinical relevance of the outcomes probably is lower than suggested and many of the outcomes can be the result of multiple testing.

In the results section, authors present the change in odds, mentioned as a percentage. I feel that this should not be done.

- *We are grateful to the reviewer for pointing this out. Percentages are no longer presented.*

First, the outcome is quite prevalent, with 38% of all participants reporting one or more sexual health problems. As many readers may misjudge the value of odds (ratios) (by thinking that it could be interpreted as a (relative) risk, so risk increase), I feel that it is better to report (relative) risks in the first place. These figures are considerably lower. In the first part of the result section (mode of delivery) the reported 18%, 35% and 10% (odds) correspond with 10%, 19% and 6% increased risk.

- *This is a good point. The difference between the results presented as odds ratios and relative risks is now illustrated in the discussion, p. 9.*

Next, all odds ratios (or relative risks) should be presented in close conjunction with the absolute risk of the outcome, to help readers understand the clinical relevance of these results.

- *Absolute risk of the outcome is presented in abstract, results section and tables.*

Authors have chosen to present OR and CI. Although in general this provides information about the statistical significance of findings, it impairs the interpretation of multiple testing. I believe that p-values should also be presented and Bonferroni correction should be applied.

After doing so, I very much wonder which results/conclusions remain. To be honest, I feel that the value of this paper can only be judged after these changes are made.

- *We appreciate the reviewer's concern, and we understand that there are differing opinions about the correct use of p-values. We have chosen to report a measure of association and the confidence interval as a measure of precision, but not to report p-values. This is in accordance with recommendations made by Kenneth Rothman in both his comment to the American Statistical Association's statement on p-values, and in Modern Epidemiology, 3rd edition, where the use of Bonferroni methods is also discouraged.*

One other comment/question: although authors give detailed information about the reasons for the various (sub)analyses, it remains unclear to me why women without a partner were excluded from all

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2
3 analyses? Was all information restricted to heterosexual sexual activities in women with a partner? If
4 so, why?
5

- 6 • *This is now elaborated upon in the section on study participants, p. 6.*

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10 Reviewer: 2

11
12 This manuscript reports the findings of a large and rigorous registry-based study which combined
13 long-term (i.e., mean interval since the women's first birth to the maternal follow-up 16 years)
14 follow-up data from the Danish National Birth Cohort about the mode of delivery and perineal tears
15 with survey data on self-reported sexual health and sexual problems. Questions were adapted from
16 the Danish National Health Survey.

17
18 Reported findings confirmed previously published data concerning the prevalence of sexual
19 complaints (thus including sexual desire disorders), then further corroborating the goodness of the
20 sample used.

21
22 Findings demonstrated that for women who only had caesarean births, significant more problems
23 were reported. Therefore, the main clinical take home message from the overall study was that
24 current findings did not support choosing caesarean section over vaginal birth in order to prevent
25 long-term sexual problems. Instead, vaginal birth appeared to be associated with fewer sexual
26 problems, even when it involves instrumental delivery, or an episiotomy.
27
28

29
30 Overall, the feeling of this Reviewer is that the study was conducted on very solid statistical bases
31 and with an exceptional sample, both for the width and the rigor of the analyzed data.

32
33 Honestly, this Reviewer believes that this type of results should be interpreted more in a sociological
34 key and with references to possible results in other European countries or even outside Europe
35 (although it could be really difficult since most countries can not carry out such an analysis because
36 they do not have such a register that also considers the issue of sexual health). This is primarily
37 because the choice of a caesarean rather than a spontaneous and physiological delivery can not be
38 conditioned by the outcomes related to sexuality, and a purely based interpretation only concerning
39 that aspect is eventually reductive.
40
41

- 42 • *We are thankful for this perspective. More references to studies in different settings have
43 been added in the discussion, as far as the limited literature in the field allows, p. 11.*

44
45
46 Likewise, there is no reference to the aspects of pelvic floor dysfunctions that might lead to urinary
47 incontinence, a retentive or disturbed micturition voiding attitude or an impaired defecation
48 behaviour, all aspects deserving of a statistical correlation with the results of this analysis.
49

- 50 • *This is a very important aspect when looking at mode of birth in a long-term follow-up. We
51 have not included incontinence in the analyses, as it can be seen from the directed acyclic
52 graph in the supplemental material that incontinence is a mediator between mode of birth
53 and sexual health. In this study, we have been interested in the total effect of mode of birth
54 on sexual health. To point out the relevance of considering risk of all pelvic floor dysfunctions
55 when choosing mode of delivery, we have added a paragraph to the discussion that explains
56 the findings from studies on mode of delivery and long-term risk of pelvic floor dysfunctions, p.
57 11.*

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4 As a further aspect which deserves to be more largely discussed, the finding concerning the specific
5 sexual problems that were more prevalent in women with a history of caesarean section, thus
6 including reduced lubrication and dyspareunia. Those results should be more comprehensively
7 discussed in biological terms and regarding potential pathophysiology pathways.
8
9

- 10 • *These findings are now discussed more in detail in the discussion, p. 11.*

11
12 Reviewer: 3

13
14
15 Very interesting and important paper!

16 However, the discussion and - if possible - data analyses should considerate in more detail the
17 "biopsychological mechanisms that cause sexual problems" and "may also reduce the likelihood of
18 vaginal birth" (respectively a preference for an caesarean section) (s. page 10, line 5-6). This is rather
19 obvious for vaginism, since women with this problem are expected to avoid vaginal birth. But it might
20 also be true for women with other psychological problems (especially those with more anxiety,
21 depression, somatoforme symptoms or insecure-avoidant personality traits). If there are any data
22 allowing analysis for psychological problems, it would be interesting to include these as a possible
23 confounding factor in the analyses, e.g. if the Data from the National Patient Registry - with all
24 contacts with Danish hospitals - has specific data about what sort of department (psychiatric or
25 psychosomatic) had been contacted by these women. Even if maternal requests for caesarean
26 section were rare in Denmark in the 1990s and 2000s (page 10), those psychological problems in
27 women might have influenced the gynecologists / physicians indication for (or against) a caesarean
28 section.
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- 34 • *We agree that mental illness may be an important confounder, and we have emphasised this
35 in the discussion. Mental illness is adjusted for in the analyses in the revised manuscript as
36 well as in the previous version of the manuscript, cf. p. 10.*

37
38
39 Some minor suggestions:

40 1. In Table 1 I would find percentages of the different sociodemographic and health factors for each
41 mode of delivery more helpful (than the percentages of each mode of delivery per factor), to see
42 whether some (possible confounding / covariate) factor might be under- or overrepresented in the
43 different mode of delivery. This table should also include statistics on whether there are any
44 significant differences in these factors between the different modes of delivery.
45
46

- 47 • *We now provide column percentages in all tables and agree that this is much clearer. With
48 regards to p-values, we refer to our answer to the comment on p-values from reviewer 1.*

49
50 2. There is a contradiction (?) between the figures/percentages of women with at least one
51 instrumental vaginal delivery on page 7, line 52/53 (n= 6 359 /17%) and those in table 1 (n=5 003,
52 13%).
53

- 54 • *We are grateful to the reviewer for pointing out that we have been unclear in our descriptions.
55 We have clarified in the results section why these numbers are not the same, p. 8.*

STROBE Statement—Checklist of items that should be included in reports of *cohort studies*

	Item No	Recommendation	Page No
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2-3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	6
		(b) For matched studies, give matching criteria and number of exposed and unexposed	Not applicable
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	4-6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	4
Bias	9	Describe any efforts to address potential sources of bias	6-7
Study size	10	Explain how the study size was arrived at	6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6-7
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	7
		(b) Describe any methods used to examine subgroups and interactions	7
		(c) Explain how missing data were addressed	7
		(d) If applicable, explain how loss to follow-up was addressed	Not applicable
		(e) Describe any sensitivity analyses	7
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6 and figure 1
		(b) Give reasons for non-participation at each stage	6
		(c) Consider use of a flow diagram	Figure 1
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8-9
		(b) Indicate number of participants with missing data for each variable of interest	Table 1 and supplement 8
		(c) Summarise follow-up time (eg, average and total amount)	8
Outcome data	15*	Report numbers of outcome events or summary measures over time	Table 2 and 3

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2			
3	Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included
4			
5			
6			(b) Report category boundaries when continuous variables were categorized
7			(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
8			
9			
10	Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
11			
12			
13	Discussion		
14	Key results	18	Summarise key results with reference to study objectives
15	Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
16			
17			
18	Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
19			
20	Generalisability	21	Discuss the generalisability (external validity) of the study results
21			
22	Other information		
23	Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based
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*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at <http://www.strobe-statement.org>.

BMJ Open

Mode of birth and long-term sexual health: a follow-up study of mothers in the Danish National Birth Cohort

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Primary Subject Heading:	Obstetrics and gynaecology
Secondary Subject Heading:	Epidemiology
Keywords:	OBSTETRICS, EPIDEMIOLOGY, PUBLIC HEALTH

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Manuscripts

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7 **Mode of birth and long-term sexual health:**
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9 **a follow-up study of mothers in the Danish National Birth Cohort**
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15 Sarah Hjorth MSc¹, Helene Kirkegaard PhD¹, Jørn Olsen PhD², Jim G Thornton MD³,
16 Ellen A Nohr PhD^{1,4}
17
18
19
20
21
22

23
24 ¹ Research Unit of Gynecology and Obstetrics, Department of Clinical Research, University of
25 Southern Denmark, Odense, Denmark
26

27 ² Department of Clinical Epidemiology, Aarhus University Hospital, Aarhus, Denmark
28

29 ³ Department of Child Health, Obstetrics and Gynaecology, University of Nottingham, Nottingham,
30 UK
31

32 ⁴ Centre of Women's, Family and Child Health, University of South-Eastern Norway, Kongsberg,
33 Norway
34
35
36

37 Word count: 3 209 words
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39
40

41 Correspondence to

42 Sarah Hjorth

43 Pharmacology and Drug Safety Research Group, Department of Pharmacy, Faculty of
44 Mathematics and Natural Sciences, University of Oslo, P.O 1068, Blindern, 0316 Oslo, Norway
45
46
47

48 email: s.h.andersen@farmasi.uio.no

49 telephone : +45 50564818
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ABSTRACT

Objectives

To investigate the relation between mode of birth and women's long-term sexual health.

Design

Maternal follow-up of the Danish National Birth Cohort (1996-2002) in 2013-2014 including questions on sexual health. Logistic regression was used to relate registry-based information about mode of birth and perineal tears with data on sexual problems.

Setting

Denmark.

Participants

Of 82 569 eligible mothers in the Danish National Birth Cohort, 43 639 (53%) completed the follow-up. Of these, 37 417 women had a partner, and answered at least one question on sexual health.

Main outcome measures

Self-reported sexual health.

Results

Participants were on average 44 years old, and 16 years after their first birth. The frequency of sexual problems among women with only spontaneous vaginal births, the reference group, was 37%. For women who only had caesarean sections, more problems were reported (OR 1.18; 95% CI 1.09 to 1.28). For women who had a spontaneous vaginal birth subsequent to a caesarean, and for women with only vaginal births who had experienced one or more instrumental vaginal births, the odds of sexual problems did not differ from women with only spontaneous vaginal births (OR 1.00; 95% CI 0.91 to 1.11) and (OR 1.01; 95% CI 0.95 to 1.08) respectively.

Conclusions

These findings indicate that caesarean section does not protect against long-term sexual problems. Rather, vaginal birth, even after caesarean section, was associated with fewer long-term sexual problems.

Keywords

Mode of birth, sexual health, caesarean section, perineal tears, Danish National Birth Cohort

STRENGTHS AND LIMITATIONS OF THIS STUDY

- This study is the largest study on mode of birth and long-term sexual health to date with 37 417 participants, allowing for a detailed investigation of the exposure.
- Information on mode of birth was obtained from registries, limiting the risk of differential misclassification.
- Participation in the maternal follow-up was 53%, which may limit the generalisability of the study.
- Chance and residual confounding, including confounding by birth route indication, cannot be ruled out, but the results were stable in sensitivity analyses.

INTRODUCTION

Sexual health is an important part of reproductive health,¹ and quality of life.² It is influenced by many factors, including women's reproductive history.³ Short term studies have shown that mode of birth, and perineal injury are associated with sexual problems up to 18 months post-partum.³⁻⁶ Although the only randomised trial of mode of birth, where one group of women was allocated to planned caesarean section and the other to planned vaginal birth, reported no significant differences after two years of follow-up, the point estimates for pain and being unhappy during sex marginally favoured caesarean section.⁷ There is also a widespread lay belief that caesarean section, perhaps by maintaining vaginal tone, or avoiding perineal injury, might improve sexual function.

The results of longer-term studies are inconsistent.⁸⁻¹² One found reduced desire in women with previous instrumental birth, and reduced lubrication in women with a history including both caesarean section and vaginal birth.¹² Another reported no associations between mode of birth and sexual problems.¹⁰ For women with anal sphincter tears, some studies found no effect,^{9,12} while others observed a higher prevalence of reduced lubrication¹⁰ or dyspareunia.¹¹

We investigated the associations between reproductive history and long-term sexual problems in a large cohort of Danish mothers. Our hypotheses were that instrumental vaginal birth would be associated with a higher risk of sexual problems than spontaneous birth whereas caesarean section would not, and that women with birth induced perineal injuries would have more sexual problems than women without.

METHODS

Data sources

The study was based on data from the Danish National Birth Cohort.^{13,14} The cohort enrolled 91 386 women in early pregnancy between 1996 and 2002, about 30% of births in that period.¹⁵ The first interview, conducted around week 16 of gestation, included information on health, lifestyle, and socio-occupational factors. Participants consented to use of their information from Danish health and social registries. Between December 2013 and December 2014, participants were invited to respond to a questionnaire on physical, mental, and sexual health. Altogether, 53% (43 639 women) of eligible mothers participated.¹⁶

Under Danish law, ethical permission is not required for public registry-based studies.¹⁷ The Danish National Birth Cohort was initially approved by the Committee on Biomedical Research Ethics (reference no. [KF] 01-471/94) and all participants gave written, informed consent. This study was also approved by the Danish Data Protection Agency (approval no. 2014-41-2848).

Outcome

The outcome was self-reported sexual health. Participants provided information about whether their sexual needs had been met in the past year, the frequency of sexual activity with a partner, their experience of dyspareunia, vaginismus, insufficient lubrication, and difficulty in getting an orgasm. They were also asked about sexual desire, and whether any lack of desire was considered problematic by them or their partner. Questions were adapted from the Danish National Health Survey¹⁸ (supplemental table 1).

Four types of sexual difficulties were dichotomised into the presence or absence of a sexual problem in the past year. Reduced lubrication or difficulty in achieving orgasm were considered a problem if the women had answered that they 'often' or 'always' had experienced these difficulties during sex with their partner. Dyspareunia was classified by location, at the vaginal introitus (entry dyspareunia) and/or deep in the abdomen (deep dyspareunia), and considered a problem if women reported that they 'sometimes', 'often' or 'always' had either type. In addition, we defined frequent dyspareunia if it was present 'often' or 'always'. Reduced sexual desire was considered a problem if women both 'sometimes', 'often' or 'always' experienced it, and also considered it a problem. All four specific sexual problems (reduced lubrication, difficulty in achieving orgasm, dyspareunia, and reduced sexual desire) were combined in one outcome, 'the presence or absence of one or more sexual problems within the past year'.

Exposures

Exposures were mode of birth and perineal tears from the woman's entire reproductive history. These were obtained from the Danish Medical Birth Registry, which contains data about all live and still births since 1973,¹⁹ and from the National Patient Registry, which contains data about all contacts with Danish hospitals since 1977.²⁰ Registry data up to the date the woman answered the follow-up questionnaire were linked to cohort participants through personal identification numbers. Mode of birth was categorised as only spontaneous vaginal births, one or more instrumental vaginal births in women with only vaginal births, only caesarean sections, one or more spontaneous vaginal births after a first caesarean section, instrumental vaginal birth in women who birthed vaginally after a first caesarean section, and caesarean section after vaginal birth.

Data on perineal tears were first kept and stored in Denmark from 1994 using ICD10. For this study, perineal tears were categorised as no tear, first (ICD10 code O70.0), second (O70.1), third (O70.2), or fourth degree tear (O70.3), or episiotomy (procedure code KTMD00). During the years, the women from the cohort gave birth, it was common practice to register only sutured tears, and many first degree tears were left unsutured. No tear and first degree tears were therefore combined into one category. As fourth degree tears amount to only 1% of perineal tears, they were combined with third degree tears in a single category 'anal sphincter tear'. Data on third and fourth degree tears analysed separately is available in supplemental table 2. Anal sphincter tear together with an episiotomy was categorised as the former.

Potential covariates

Covariates were chosen a priori based on a literature review, and depicted in directed acyclic graphs²¹ (supplemental figure 1). Maternal age at first birth, and calendar year at first birth were obtained from the Medical Birth Registry. Information about socio-occupational status, pre-pregnant body mass index (BMI), mental-, and physical health, and smoking and exercise in pregnancy came from the woman's first interview in the Danish National Birth Cohort, and was thus related to her first childbirth in the cohort. For 51% of participants, this was also their first birth. Socio-occupational status was categorised as high (four or more years of education after high school, or job as manager), middle (skilled manual work, office or service work), or low (unskilled work or unemployment).²² Diseases were defined as those that had been diagnosed by a physician, and included hypertensive disorders, diseases of the heart, thyroid, or musculoskeletal system, epilepsy, diabetes, gynaecological diseases, and mental illness. Self-assessed health at the first pregnancy, smoking in pregnancy, and exercise in pregnancy were categorised as shown in table 1.

Study population

Women who participated in the follow-up and answered at least one question on sexual health (n=42 132) were eligible. Two separate analyses were done, one for mode of birth, and one for degree of perineal tear. Study populations varied slightly in the two analyses (figure 1). For both study populations, we excluded 4 715 (11%) women without a partner, as they were not considered comparable with women with a partner when it came to sexual activity and sexual problems.

Women without a partner were less sexually active, less likely to feel that their sexual needs were met, and less likely to consider any reduced desire problematic. The sexual health of women with and without a partner can be compared in supplemental table 1. The study included women with male and/or female partners. In the study population for mode of birth, 37 417 women were included. For the analysis on perineal tears, 3 240 women (8%) who only had caesarean sections were excluded. Another 4 920 women (12%) with births before 1994, when degree of perineal tear registration started, were excluded, leaving 29 253 women in the study population.

Figure 1 about here

Participant and public involvement

Some study participants were involved in developing and testing the questionnaire in the maternal follow-up. The results of the research conducted in the Danish National Birth Cohort are available at www.dnbc.dk.

Statistical analysis

To estimate the association between mode of birth, or degree of perineal tear, and the prevalence of sexual problems, we used logistic regression for calculating odds ratios (ORs) with 95% confidence intervals (CIs). For mode of birth, the reference group was women who had only delivered spontaneously. For perineal tears, the reference group was "no tear or first degree tear". Multiple logistic regressions were adjusted for age, year at first birth, and pre-pregnant BMI as continuous variables, and socio-occupational status, self-assessed health, disease, exercise, and smoking in pregnancy as categorical variables. The number of answers available for analysis for each outcome differed, as the response option 'I do not wish to answer this question' was provided for all questions on sexual health, and only participants with complete information on exposure and outcome were analysed. To address missing data on covariates, multivariate imputation by chained equations was done, and the number of datasets created was 20, as no difference in results was seen

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2 when moving from ten to 20 datasets. As recommended by Sterne et al.,²³ both exposure, outcome,
3 and covariates with complete information were included in the imputation model. Complete case
4 analyses were done as well, and the results did not differ substantially from the results based on
5 multiple imputation (supplemental tables 3 and 4). For non-participants in the maternal follow-up,
6 we also had available data on mode of birth and degree of tear, and the distributions were compared
7 to that observed in participants and found to be similar (supplemental table 5). Because some
8 categories of mode of birth could only include women with more than one child, the categorisation
9 may be seen as a conditioning on parity or future events. In a sensitivity analysis, we therefore
10 adjusted for parity and year at last birth, even though they were also considered intermediates in the
11 directed acyclic graph. As vaginismus is associated with a lower prevalence of vaginal births, a
12 second sensitivity analysis excluded women with vaginismus. In a third sensitivity analysis, the
13 population was restricted to women who had their first child in the Danish National Birth Cohort, as
14 women who choose to have another child may represent a selected group, where women who have
15 the worst experiences of childbirth, or who have sequelae, are under-represented. All analyses were
16 done using Stata 13.1 (StataCorp, College Station, Texas, USA).
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29 **RESULTS**

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31 The mean age of participants at follow-up was 44 years (SD 4.4), and the mean interval since the
32 women's first birth to the maternal follow-up 16 years (SD 3.8, range 11 to 40 years). Socio-
33 occupational status, BMI, and smoking and exercise practice in pregnancy are shown in table 1.
34 Most women, 23 608 (63%), had delivered all of their children spontaneously. For 6 359 women
35 (17%), their reproductive history included at least one instrumental vaginal birth, almost all of
36 which were vacuum extractions (99%). Some of these women also had a caesarean section in their
37 reproductive history. In 8 806 women (24%), at least one birth had been by caesarean section, and 3
38 244 women (8%) had only caesarean sections.
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Table 1. Participant characteristics by mode of birth.

	Mode of birth						
	All (n=37 417)	Only spontaneous births (n=23 608)	Instrumental vaginal birth, ever (n=5 003)	Only c-sections (n=3 244)	Spontaneous VBAC (n=2 038)	Instrumental VBAC (n=457)	C-section after vaginal birth (n=3 067)
Age at first birth, n (%)							
<25	7 140 (19)	4 864 (21)	775 (15)	363 (11)	356 (17)	75 (16)	707 (23)
25–29	19 839 (53)	12 758 (54)	2 656 (53)	1 433 (44)	1 144 (56)	233 (51)	1 615 (53)
30–34	8 614 (23)	5 063 (21)	1 280 (26)	1 024 (32)	465 (23)	125 (27)	657 (21)
≥35	1 824 (5)	923 (4)	292 (6)	424 (13)	73 (4)	24 (5)	88 (3)
Socio-occupational status, n (%)*							
Low	2 233 (6)	1 393 (6)	265 (6)	202 (7)	123 (6)	28 (7)	222 (8)
Middle	11 832 (34)	7 444 (34)	1 562 (33)	1 056 (35)	656 (34)	133 (31)	981 (34)
High	21 059 (60)	13 318 (60)	2 875 (61)	1 779 (59)	1 133 (59)	269 (63)	1 685 (58)
Missing	2 293	1 453	301	207	126	27	179
Prepregnant BMI, n (%)*							
<18.5	1 417 (4)	906 (4)	196 (4)	87 (3)	82 (4)	26 (6)	120 (4)
18.5–24.9	24 554 (71)	15 991 (73)	3 275 (70)	1 843 (62)	1 286 (68)	268 (63)	1 891 (66)
25.0–29.9	6 405 (18)	3 748 (17)	899 (19)	697 (23)	369 (20)	93 (22)	599 (21)
≥30.0	2 321 (7)	1 249 (6)	278 (6)	355 (12)	150 (8)	37 (9)	252 (9)
Missing	2 720	1 714	355	262	151	33	205
Exercise in pregnancy, min/week, n (%)*							
None	21 156 (60)	13 137 (59)	2 881 (61)	1 888 (62)	1 149 (60)	274 (64)	1 827 (63)
1–180	11 184 (32)	7 222 (33)	1 475 (31)	900 (30)	615 (32)	122 (28)	850 (29)
>180	2 826 (8)	1 825 (8)	348 (7)	255 (8)	148 (8)	33 (8)	217 (8)
Missing	2 251	1 424	299	201	126	28	173
Smoking in pregnancy, n (%)*							

Table 1. Participant characteristics by mode of birth (continued)

	Mode of birth						
	All (n=37 417)	Only spontaneous births (n=23 608)	Instrumental vaginal birth, ever (n=5 003)	Only c-sections (n=3 244)	Spontaneous VBAC (n=2 038)	Instrumental VBAC (n=457)	C-section after vaginal birth (n=3 067)
No smoking	28 295 (80)	17 973 (80)	3 774 (80)	2 372 (77)	1 545 (80)	352 (81)	2 279 (78)
Smoking cessation	3 099 (9)	1 892 (8)	425 (9)	318 (10)	173 (9)	28 (6)	263 (9)
Smoking	4062 (11)	2 489 (11)	536 (11)	378 (12)	222 (11)	54 (12)	383 (13)
Missing	1 961	1 254	268	176	98	23	142
Self-assessed health, n (%)*							
Very good	19 750 (56)	12 630 (57)	2 642 (56)	1 631 (53)	1 079 (56)	228 (53)	1 540 (53)
Normal	14 578 (41)	9 056 (41)	1 963 (42)	1 319 (43)	798 (41)	195 (45)	1 247 (43)
Not so good	970 (3)	576 (3)	116 (2)	109 (4)	47 (2)	11 (3)	111 (4)
Missing	2 119	1 346	282	185	114	23	169
Presence of disease, n (%)*†							
No	20 305 (58)	13 105 (59)	2 774 (59)	1 577 (52)	1 095 (57)	251 (58)	1 503 (52)
Yes	14 855 (42)	9 070 (41)	1 932 (41)	1 468 (48)	820 (43)	182 (42)	1 383 (48)
Missing	2 257	1 433	297	199	123	24	181

*Percentage of non-missing values.

†Diseases that, according to the women, had been confirmed by a physician, including hypertensive disorders, diseases of the heart, thyroid, or musculoskeletal system, epilepsy, diabetes, gynaecological diseases, and mental illness.

BMI: Body mass index. C-section: Caesarean section. VBAC: Vaginal birth after caesarean section.

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2 Of the 36 691 women who answered the question on sexual needs, 25 289 women (69%) felt that
3 their needs had been met completely or almost completely within the past year (supplemental table
4 1). Of the 35 710 women who answered all questions on sexual problems, 13 449 (38%) reported
5 one or more sexual problems. Reduced or lacking sexual desire was the most prevalent sexual
6 difficulty, and 7 945 women (22%) had experienced reduced desire to an extent that they found
7 problematic for themselves. Reduced desire to an extent that the women felt was problematic for
8 their partner was experienced by 35%.

15 **Mode of birth**

16 Compared to women with only spontaneous vaginal births, there was no evidence for a difference in
17 the prevalence of any sexual problems in women with instrumental vaginal births (table 2). Odds
18 for one or more sexual problems were increased in women who had only delivered by caesarean
19 section (OR 1.18; 95% CI 1.09 to 1.28), in women who had an instrumental vaginal birth after
20 caesarean section (OR 1.35; 95% CI 1.11 to 1.64), and in women who had a caesarean section after
21 vaginal birth (OR 1.10; 95% CI 1.01 to 1.19), but not in women with spontaneous vaginal birth
22 after caesarean section (OR 1.00; 95% CI 0.91 to 1.11). The specific sexual problems that were
23 more prevalent in women with a history of caesarean section were reduced lubrication (OR=1.41,
24 95% CI 1.24 to 1.60) and dyspareunia (OR=1.78, 95% CI 1.59 to 1.99), including frequent
25 dyspareunia (OR=2.82, 95% CI 2.32 to 3.41) (supplemental table 6). When asked about the
26 localisation of the pain, odds ratios for women with only caesarean section were higher for entry
27 dyspareunia (OR=2.76, 95% CI 2.36 to 3.24) than for deep dyspareunia (OR=1.25, 95% CI 1.08 to
28 1.45).

Table 2: Sexual problems by mode of birth.

	Only spon- taneous births	Instrumental vaginal birth, ever	Only c-sections	Spontaneous VBAC	Instrumental VBAC	C-section after vaginal birth
One or more sexual problem(s), n=35 710						
Cases (%)	8 323 (37)	1 788 (37)	1 278 (42)	718 (37)	194 (45)	1 148 (39)
Crude OR (95% CI)	Reference	1.02 (0.96–1.09)	1.24 (1.15–1.34)	1.01 (0.92–1.11)	1.37 (1.14–1.66)	1.11 (1.03–1.20)
Adjusted OR* (95% CI)	Reference	1.01 (0.95–1.08)	1.18 (1.09–1.28)	1.00 (0.91–1.11)	1.35 (1.11–1.64)	1.10 (1.01–1.19)
Reduced desire, n=36 509						
Cases (%)	4 981 (22)	1 042 (21)	723 (23)	437 (22)	106 (24)	656 (22)
Crude OR (95% CI)	Reference	0.99 (0.92–1.07)	1.09 (1.00–1.19)	1.03 (0.92–1.15)	1.13 (0.91–1.41)	1.03 (0.94–1.13)
Adjusted OR* (95% CI)	Reference	0.99 (0.92–1.07)	1.05 (0.96–1.15)	1.03 (0.92–1.15)	1.13 (0.91–1.41)	1.02 (0.93–1.11)
Difficulty in obtaining orgasm, n=36 019						
Cases (%)	2 861 (13)	641 (13)	421 (14)	255 (13)	73 (17)	399 (14)
Crude OR (95% CI)	Reference	1.07 (0.97–1.17)	1.10 (0.99–1.23)	1.04 (0.91–1.20)	1.39 (1.08–1.79)	1.09 (0.98–1.22)
Adjusted OR* (95% CI)	Reference	1.06 (0.96–1.16)	1.06 (0.95–1.18)	1.04 (0.91–1.19)	1.38 (1.07–1.78)	1.09 (0.97–1.22)
Insufficient lubrication, n=36 148						
Cases (%)	1 700 (7)	383 (8)	344 (11)	138 (7)	46 (10)	298 (10)
Crude OR (95% CI)	Reference	1.07 (0.95–1.20)	1.55 (1.37–1.76)	0.94 (0.78–1.12)	1.44 (1.06–1.96)	1.39 (1.23–1.59)
Adjusted OR* (95% CI)	Reference	1.01 (0.90–1.13)	1.41 (1.24–1.60)	0.92 (0.77–1.10)	1.35 (0.99–1.85)	1.35 (1.18–1.54)
Dyspareunia, n=36 266						
Cases (%)	2 040 (9)	446 (9)	467 (15)	170 (9)	57 (13)	319 (11)
Crude OR (95% CI)	Reference	1.03 (0.93–1.15)	1.81 (1.62–2.02)	0.96 (0.82–1.13)	1.50 (1.13–1.99)	1.23 (1.09–1.40)

Table 2: Sexual problems by mode of birth (continued).

	Only spon- taneous births	Instrumental vaginal birth, ever	Only c-sections	Spontaneous VBAC	Instrumental VBAC	C-section after vaginal birth
Adjusted OR* (95% CI)	Reference	1.05 (0.94–1.17)	1.78 (1.59–1.99)	0.97 (0.82–1.14)	1.52 (1.14–2.01)	1.20 (1.06–1.36)
Entry dyspareunia,						
n=35 720						
Cases (%)	640 (3)	160 (3)	243 (8)	68 (4)	25 (6)	117 (4)
Crude OR (95% CI)	Reference	1.19 (1.00–1.42)	2.99 (2.57–3.49)	1.24 (0.96–1.60)	2.09 (1.38–3.15)	1.43 (1.17–1.75)
Adjusted OR* (95% CI)	Reference	1.14 (0.96–1.37)	2.76 (2.36–3.24)	1.24 (0.96–1.59)	2.03 (1.35–3.07)	1.41 (1.15–1.73)
Deep dyspareunia,						
n=35 720						
Cases (%)	1 425 (6)	278 (6)	233 (8)	102 (5)	36 (8)	203 (7)
Crude OR (95% CI)	Reference	0.92 (0.80–1.05)	1.24 (1.07–1.43)	0.82 (0.67–1.01)	1.34 (0.95–1.89)	1.11 (0.95–1.29)
Adjusted OR* (95% CI)	Reference	0.96 (0.84–1.09)	1.25 (1.08–1.45)	0.83 (0.67–1.02)	1.38 (0.98–1.96)	1.07 (0.91–1.25)

*Adjusted for maternal age at first birth, calendar year at first birth, pre-pregnant body mass index, socio-occupational status, self-assessed health, disease, exercise in pregnancy, and smoking in pregnancy.

C-section: Caesarean section; CI: Confidence interval; OR: Odds ratio; VBAC: Vaginal birth after caesarean section.

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2 Among women with one or more vaginal births, 16 404 (56%), had no tear or a first degree tear
3 (supplemental table 7). Episiotomy was frequently used in 1997 to 2002, and 6 615 women (23%)
4 had a second degree tear from a mediolateral episiotomy as their largest tear. Anal sphincter tears
5 were seen in 1 967 women (7%).
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10 Neither second degree tears nor episiotomies were associated with increased odds of any of the
11 studied sexual problems (table 3). Women with previous episiotomies had lower odds of deep
12 dyspareunia (OR=0.87, 95% CI 0.77 to 0.99) than women with no tear or a first degree tear.
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15 Women with previous anal sphincter tears had moderately higher odds of reduced lubrication and
16 entry dyspareunia (OR 1.20, 95% CI 1.01 to 1.43, & OR 1.34, 95% CI 1.04 to 1.73, respectively).
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19 The latter association was unaltered when frequent dyspareunia was considered (supplemental table
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Table 3: Sexual problems by degree of perineal tear.

	No tear/first degree	Second degree	Episiotomy	Anal sphincter tear
One or more sexual problem(s), n=27 992				
Cases (%)	5 882 (37)	1 560 (38)	2 278 (36)	716 (38)
Crude OR (95% CI)	Reference	1.04 (0.97–1.12)	0.95 (0.90–1.01)	1.03 (0.93–1.14)
Adjusted OR* (95% CI)	Reference	1.03 (0.96–1.11)	0.95 (0.90–1.01)	1.02 (0.92–1.12)
Reduced sexual desire, n=28 586				
Cases (%)	3 523 (22)	935 (22)	1 342 (21)	423 (22)
Crude OR (95% CI)	Reference	1.02 (0.94–1.11)	0.94 (0.87–1.00)	1.01 (0.90–1.13)
Adjusted OR* (95% CI)	Reference	1.01 (0.93–1.10)	0.95 (0.88–1.01)	1.00 (0.89–1.12)
Difficulty in obtaining orgasm, n=28 217				
Cases (%)	2 006 (13)	553 (14)	817 (13)	261 (14)
Crude OR (95% CI)	Reference	1.08 (0.97–1.19)	1.02 (0.93–1.11)	1.11 (0.96–1.27)
Adjusted OR* (95% CI)	Reference	1.07 (0.96–1.18)	1.01 (0.93–1.11)	1.09 (0.95–1.25)
Insufficient lubrication, n=28 308				
Cases (%)	1 133 (7)	314 (8)	481 (8)	163 (9)
Crude OR (95% CI)	Reference	1.08 (0.95–1.23)	1.06 (0.95–1.19)	1.22 (1.03–1.45)
Adjusted OR* (95% CI)	Reference	1.09 (0.96–1.25)	1.02 (0.91–1.14)	1.20 (1.01–1.43)
Dyspareunia, n=28 398				
Cases (%)	1 469 (9)	372 (9)	562 (9)	184 (10)
Crude OR (95% CI)	Reference	0.98 (0.87–1.10)	0.95 (0.86–1.05)	1.05 (0.90–1.24)
Adjusted OR* (95% CI)	Reference	0.97 (0.86–1.10)	0.96 (0.87–1.07)	1.07 (0.91–1.25)
Entry dyspareunia, n=28 006				
Cases (%)	453 (3)	115 (3)	201 (3)	74 (4)

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Table 3: Sexual problems by degree of perineal tear (continued).

	No tear/first degree	Second degree	Episiotomy	Anal sphincter tear
Crude OR (95% CI)	Reference	0.98 (0.80–1.21)	1.11 (0.94–1.31)	1.38 (1.08–1.78)
Adjusted OR* (95% CI)	Reference	0.98 (0.79–1.20)	1.09 (0.92–1.30)	1.34 (1.04–1.73)
<i>Deep dyspareunia, n=28 006</i>				
Cases (%)	1 035 (7)	265 (7)	355 (6)	117 (6)
Crude OR (95% CI)	Reference	0.99 (0.86–1.14)	0.85 (0.75–0.96)	0.94 (0.77–1.15)
Adjusted OR* (95% CI)	Reference	0.98 (0.85–1.13)	0.87 (0.77–0.99)	0.97 (0.80–1.19)

*Adjusted for maternal age at first birth, calendar year at first birth, pre-pregnant body mass index, socio-occupational status, self-assessed health, disease, exercise in pregnancy, and smoking in pregnancy.
CI: Confidence interval; OR: Odds ratio.

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2 In sensitivity analyses, adjusting for parity and year at last birth did not change the results (data not
3 shown), and restricting the population to women who had their first birth in the Danish National
4 Birth Cohort only changed the results marginally (supplemental tables 9 and 10). Vaginismus was
5 rare in this study population (1%), but more prevalent in women who had a history of caesarean
6 section. However, results were not substantially altered when we excluded women with vaginismus
7 (supplemental table 11).
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13 14 **DISCUSSION**

15 In this large sample of Danish mothers, a history of caesarean section was associated with an
16 increased risk of sexual problems in midlife compared with women who had only birthed vaginally.
17 The estimated effect sizes were small to moderate, but if causative would be clinically important.
18 For example, women who had only given birth by caesarean section had a relative risk of 1.11 of
19 sexual problems in later life. This 11 percent proportional increase amounts to a five percentage
20 points absolute increase from 37 to 42 percent. In contrast, instrumental vaginal birth was not
21 associated with long-term sexual problems. Among women who had delivered by caesarean but had
22 a subsequent spontaneous vaginal birth, the risk of long-term sexual problems was similar to those
23 who had only birthed vaginally.
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33 Strengths of this study include study size, and long-term follow-up with linkage to registry data,
34 allowing a detailed investigation of exposures while limiting the risk of differential
35 misclassification. Limitations include a participation rate of 53%. A recent study found that
36 participants in the maternal follow-up were older, and of higher socio-occupational status and
37 healthier lifestyle than non-participants, but also that selected exposure-outcome associations were
38 not substantially affected by selection bias.¹⁶ However, the relatively high socio-occupational level
39 of participants could affect generalisability. Residual confounding, including confounding by time-
40 varying factors and confounding by indication, should be considered. A study found lower
41 prevalence of vaginal births in women with vaginismus.²⁴ It is possible that some of the
42 biopsychological mechanisms that cause sexual problems may also alter the likelihood of vaginal
43 birth. Among these mechanisms could be mental or somatic illness, which we adjusted for in our
44 analysis, but also vaginismus prior to childbirth, for which we did not have information. This could
45 draw the results towards an association between caesarean section and more sexual problems.
46 However, caesarean section on maternal request was rare in Denmark in the 1990s and 2000s – less
47 than 2% of all births.²⁵ Results were unchanged when we only considered women who had their
48 first birth in the Danish National Birth Cohort. Finally, chance findings cannot be ruled out.
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4 The prevalence of sexual problems in midlife in the present study is broadly within the range from
5 previous reports. In this study, as in previous studies,^{10,12} episiotomies were not associated with
6 more sexual problems. Rather, women with episiotomies reported less deep dyspareunia than
7 women with no tears or first degree tears. Shorter second stages of labour are observed when
8 episiotomy is used,⁵ which might explain why these women have less deep dyspareunia. However,
9 at present our results do not justify a change in the advice on avoiding routine use of episiotomy.²⁶
10 Some previous studies found no association between anal sphincter tears and long-term sexual
11 problems,^{9,12} whereas others found increased risk of dyspareunia¹¹ or reduced lubrication¹⁰ as we
12 did. Scar tissue and a higher prevalence of incontinence might explain this finding, but the
13 underlying reasons for the tear could also play a role.
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23 Previous studies of long-term sexual health between different modes of birth were small.^{10,12} The
24 studies were carried out in the USA and in Switzerland, countries with different obstetric traditions
25 from Denmark, and neither found indication that caesarean section protected against sexual
26 problems in the long term.^{10,12} If the association between caesarean sections and sexual problems
27 identified in this study is causal, there are a number of possible underlying mechanisms. Abdominal
28 adhesions after caesarean section are not likely to be the whole explanation, since this would not
29 explain why women who had delivered by caesarean section also reported more entry dyspareunia,
30 nor why vaginal birth after caesarean section reduces sexual problems. It is possible that expectation
31 of deep dyspareunia can reduce lubrication and heighten the risk of entry dyspareunia. Another
32 explanation could be that the achievement of at least one vaginal birth is protective against sexual
33 problems in later life. This might be a physical effect if, contrary to anecdote, changes to the
34 perineum after vaginal birth are in some way associated with less pain or greater pleasure. There
35 may also be psychosexual benefits from achieving a vaginal birth.
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47 Caesarean section has been proposed as preventive of pelvic floor dysfunctions, such as pelvic
48 organ prolapse, and urinary and anal incontinence.⁸ The experience of pelvic floor dysfunctions
49 may in turn influence sexual health.³ Therefore pelvic floor dysfunctions can be considered as
50 intermediate factors between mode of birth and sexual health (see supplemental figure 1). For this
51 reason, we did not adjust for pelvic floor dysfunctions in the analyses. Yet, when discussing long-
52 term effects of mode of birth, knowledge about pelvic floor dysfunctions is important. Caesarean
53 section appears to protect against pelvic organ prolapse in both the short and long term.⁸ For
54 urinary incontinence, there appears to be a protective effect of caesarean section in the short term.
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2 However, as women age, this potential effect is no longer found.⁸ The current evidence does not
3 support any protective effect of caesarean section on anal incontinence outside the immediate post-
4 partum period.⁸ These factors should all be taken into account, along with sexual health, when
5 counselling a woman about the choice of mode of birth.
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10 Our findings do not support choosing caesarean section over vaginal birth in order to prevent long-
11 term sexual problems. Instead, vaginal birth appears to be associated with fewer sexual problems,
12 even when it involves instrumental birth, or an episiotomy.
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17 **CONTRIBUTOR AND GUARANTOR INFORMATION**

18 All authors contributed to the design of the study. JO and EAN were responsible for the data
19 collection. SH analysed the data with help from HK. SH, HK, EAN, JGT, and JO interpreted the
20 results. SH wrote the first draft of the manuscript, and EAN, HK, JGT, and JO critically revised it.
21 All authors approved the final manuscript. All authors are guarantors.
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28 **LICENCE FOR PUBLICATION**

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37 do any or all of the above.
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47 **DATA SHARING**

48 The data that support the findings of this study are available from the Danish National Birth Cohort
49 but restrictions apply to the availability of these data, which were used under license for the current
50 study, and so are not publicly available. All requests for data from the Danish National Birth Cohort
51 must include a short protocol with a specific research question and a plan for analysis. More
52 information can be found on www.dnbc.dk.
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58 **TRANSPARENCY**

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2 The authors affirm that this manuscript is an honest, accurate, and transparent account of the study
3 being reported; that no important aspects of the study have been omitted; and that any discrepancies
4 from the study as planned (and, if relevant, registered) have been explained.
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8 **COMPETING INTERESTS**

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10 All authors have completed the ICMJE uniform disclosure form at
11 www.icmje.org/coi_disclosure.pdf and declare: no support from any organization for the submitted
12 work; no financial relationships with any organizations that might have an interest in the submitted
13 work in the previous three years; no other relationships or activities that could appear to have
14 influenced the submitted work.
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20
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34 full access to all the data in the study, and all authors had final responsibility for the decision to
35 submit for publication.
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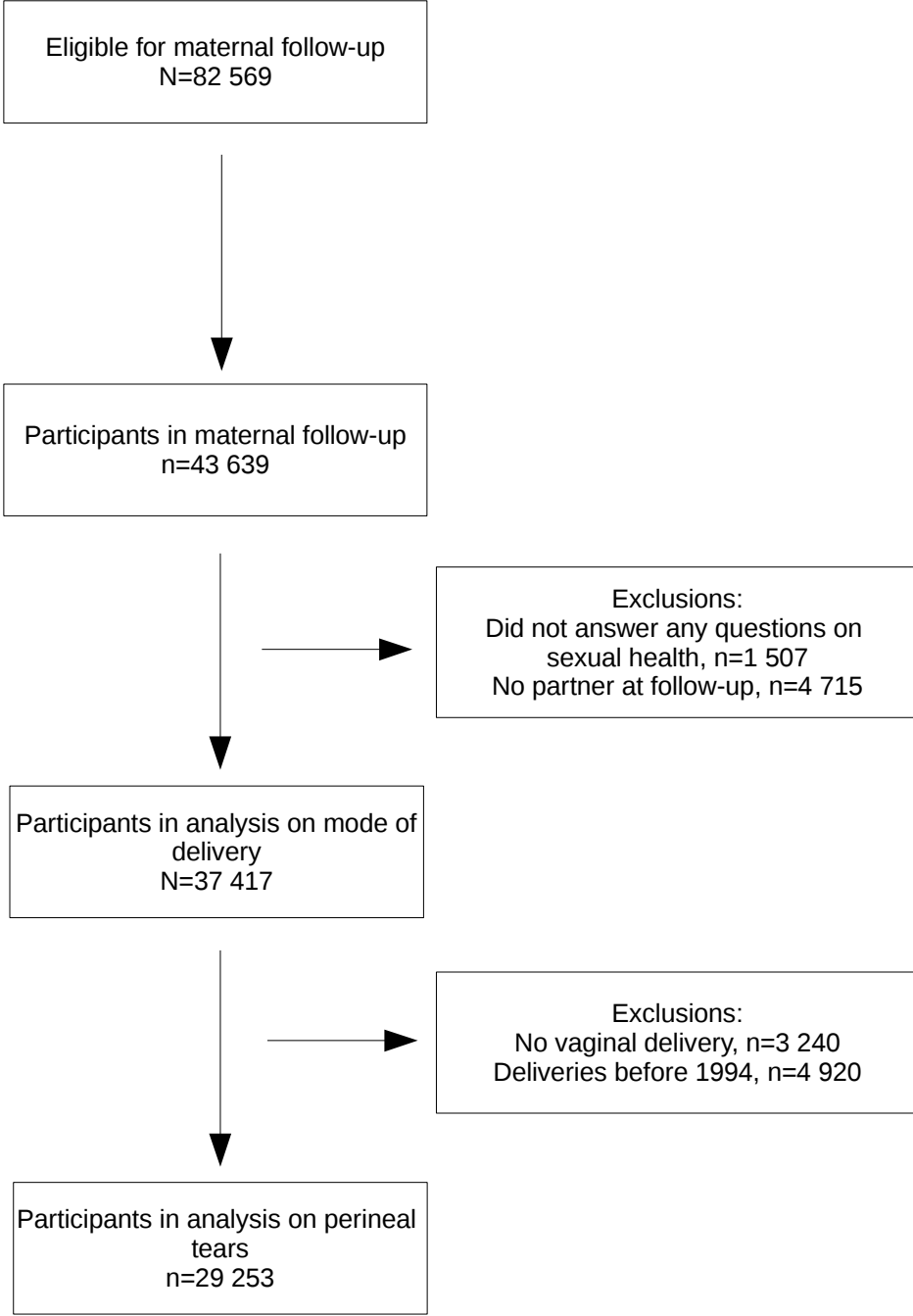
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30 **FIGURE LEGEND**

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32 Figure 1: Flow chart of the study population.
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Mode of birth and long term sexual health: a follow-up study of mothers in the Danish National Birth Cohort

Sarah Hjorth, Helene Kirkegaard, Jørn Olsen, Jim G Thornton, Ellen A Nohr

Supplemental material

The supplementary material contains:

Supplemental table 1: Sexual health in the past year (2012-2013) in mothers in their mid-forties (N=37 147).

Supplemental table 2: Sexual problems by degree of perineal tear, 3rd and 4th degree tears analysed separately.

Supplemental table 3: Sexual problems by mode of birth in participants with complete data.

Supplemental table 4: Sexual problems by degree of perineal tear in participants with complete data.

Supplemental table 5: Exposures in participants and non-participants.

Supplemental table 6: Frequent dyspareunia by mode of birth.

Supplemental table 7: Participant characteristics by degree of perineal tear.

Supplemental table 8: Frequent dyspareunia by degree of perineal tear.

Supplemental table 9: Sexual problems by mode of birth in women who had their first birth in the DNBC.

Supplemental table 10: Sexual problems by degree of perineal tear in women who had their first birth in the DNBC.

Supplemental table 11: Sexual problems by mode of birth in participants without vaginismus.

Supplemental figure 1: Directed acyclic graph.

Supplemental table 1: Sexual health in the past year (2012-2013) in mothers in their mid-forties (N=42 132).

	Women with a partner, N=37 417		Women without a partner, N=4 715	
Have your sexual needs been met?, n (%)*				
Completely	15 081	(41)	417	(9)
Almost completely	10 208	(29)	537	(12)
Partially	6 666	(18)	1 067	(23)
A little	2 248	(6)	918	(20)
Not at all	1 090	(3)	1 214	(27)
I have not had sexual needs	1 108	(3)	362	(8)
I do not know	290	(1)	52	(1)
How often have you been sexually active with another person?, n (%)*				
Every day	89	(0.2)	6	(0.1)
3–6 times a week	3 432	(9)	185	(4)
1–2 times a week	13 640	(37)	553	(12)
1–3 times a month	12 671	(35)	885	(20)
Less than once a month	4 960	(14)	1 177	(26)
Not at all	1 327	(4)	1 600	(35)
I do not know	348	(1)	122	(3)
Have you experienced lacking or reduced sexual desire?, n (%)*				
Yes, all the time	1 551	(4)	234	(5)
Yes, often	7 551	(21)	505	(11)
Yes, sometimes	13 566	(37)	755	(17)
Yes, but rarely	9 084	(25)	764	(17)
No, never	4 612	(13)	1 681	(37)
I do not know	376	(1)	608	(13)
<i>If yes, was it a problem for you?</i>				
Yes	7 945	(35)	287	(19)
No	12 220	(55)	1 077	(73)
I do not know	2 275	(10)	119	(8)
<i>Was it a problem for your partner?</i>				
Yes	12 752	(61)	-	
No	4 465	(21)	-	
I do not know	3 740	(18)	-	
Have you experienced the following during sexual activity with another person?, n (%)*				

Supplemental table 1: Sexual health in the past year (2012-2013) in mothers in their mid-forties (N=37 147) (continued).

	Women with a partner, N=37 417		Women without a partner, N=4 715	
I have not been sufficiently wet in the vagina				
Not at all	18 242	(51)	2 468	(57)
Rarely	8 272	(23)	572	(13)
Sometimes	5 938	(16)	337	(8)
Often	2 024	(6)	126	(3)
Every time	885	(2)	62	(1)
I do not know	787	(2)	770	(18)
I have not, or only with great difficulty, achieved orgasm				
Not at all	13 119	(36)	1 566	(36)
Rarely	10 580	(29)	854	(20)
Sometimes	6 853	(19)	632	(15)
Often	2 943	(8)	324	(8)
Every time	1 707	(5)	208	(5)
I do not know	817	(2)	730	(17)
I have had vaginismus that prevented intercourse				
Not at all	34 601	(95)	3 557	(82)
Rarely	638	(2)	58	(1)
Sometimes	269	(1)	17	(0.4)
Often	87	(0.2)	<5	(<0.1)
Every time	16	(<0.1)	0	(0)
I do not know	647	(2)	701	(16)
I have had pain in my genitals and/or abdomen with intercourse				
Not at all	26 965	(74)	3 019	(70)
Rarely	5 256	(14)	338	(8)
Sometimes	2 704	(7)	185	(4)
Often	584	(2)	48	(1)
Every time	211	(1)	23	(1)
I do not know	546	(2)	720	(17)
If yes, where was the pain located?†				
At the vaginal entrance	1 253	(36)	71	(28)
Deep in the abdomen	2 277	(65)	197	(77)
I do not know	228	(7)	14	(5)

*Percentage of those who have answered the question. The number of answers available for analysis for each outcome differed, as the response option 'I do not wish to answer this question' was provided for questions on sexual health and varied for all questions between 210 and 1361. In general, women without a partner more often used this answer category. The number of missing values were between 0 and 37 for all questions except 'was it a problem for your partner?' with 1503 missing values. The proportion of missing values did not differ between women with and without a partner.

†More than one answer could be given, wherefore the percentage adds up to more than 100.

Supplemental table 2: Sexual problems by degree of perineal tear, 3rd and 4th degree tears analysed separately.

	No tear/first degree	Second degree	Episiotomy	Third degree	Fourth degree
One or more sexual problem(s), n=27 992					
Cases (%)	5 882 (37)	1 560 (38)	2 278 (36)	617 (38)	99 (42)
Crude OR (95% CI)	Reference	1.04 (0.97–1.12)	0.95 (0.90–1.01)	1.01 (0.91–1.12)	1.19 (0.92–1.55)
Adjusted OR* (95% CI)	Reference	1.03 (0.96–1.11)	0.95 (0.90–1.01)	1.00 (0.90–1.11)	1.17 (0.90–1.52)
Reduced sexual desire, n=28 586					
Cases (%)	3 523 (22)	935 (22)	1 342 (21)	369 (22)	54 (22)
Crude OR (95% CI)	Reference	1.02 (0.94–1.11)	0.94 (0.87–1.00)	1.01 (0.89–1.14)	1.00 (0.74–1.36)
Adjusted OR* (95% CI)	Reference	1.01 (0.93–1.10)	0.95 (0.88–1.01)	1.00 (0.88–1.13)	0.99 (0.73–1.34)
Difficulty in obtaining orgasm, n=28 217					
Cases (%)	2 006 (13)	553 (13)	817 (13)	232 (14)	29 (12)
Crude OR (95% CI)	Reference	1.08 (0.97–1.19)	1.02 (0.93–1.11)	1.13 (0.98–1.31)	0.94 (0.64–1.39)
Adjusted OR* (95% CI)	Reference	1.07 (0.96–1.18)	1.01 (0.93–1.11)	1.12 (0.96–1.29)	0.92 (0.62–1.36)
Insufficient lubrication, n=28 308					
Cases (%)	1 133 (7)	314 (8)	481 (8)	139 (8)	24 (10)
Crude OR (95% CI)	Reference	1.08 (0.95–1.23)	1.06 (0.95–1.19)	1.19 (0.99–1.43)	1.43 (0.93–2.19)
Adjusted OR* (95% CI)	Reference	1.09 (0.96–1.25)	1.02 (0.91–1.14)	1.17 (0.97–1.41)	1.42 (0.93–1.19)
Dyspareunia, n=28 398					
Cases (%)	1 469 (9)	372 (9)	562 (9)	158 (10)	26 (11)
Crude OR (95% CI)	Reference	0.98 (0.87–1.10)	0.95 (0.86–1.05)	1.04 (0.87–1.23)	1.18 (0.78–1.77)
Adjusted OR* (95% CI)	Reference	0.97 (0.86–1.10)	0.96 (0.87–1.07)	1.05 (0.88–1.25)	1.17 (0.77–1.77)
Entry dyspareunia, n=28 006					
Cases (%)	453 (3)	115 (3)	201 (3)	62 (4)	12 (5)
Crude OR (95% CI)	Reference	0.98 (0.80–1.21)	1.11 (0.94–1.31)	1.33 (1.01–1.74)	1.77 (0.98–3.19)
Adjusted OR* (95% CI)	Reference	0.98 (0.79–1.20)	1.09 (0.92–1.30)	1.29 (0.98–1.69)	1.74 (0.97–3.15)
Deep dyspareunia, n=28 006					
Cases (%)	1 035 (7)	265 (7)	355 (6)	103 (6)	14 (6)
Crude OR (95% CI)	Reference	0.99 (0.86–1.14)	0.85 (0.75–0.96)	0.95 (0.77–1.18)	0.88 (0.51–1.51)
Adjusted OR* (95% CI)	Reference	0.98 (0.85–1.13)	0.87 (0.77–0.99)	0.99 (0.80–1.22)	0.88 (0.51–1.51)

*Adjusted for maternal age at first birth, calendar year at first birth, pre-pregnant body mass index, socio-occupational status, self-assessed health, disease, exercise in pregnancy, and smoking in pregnancy.

CI: Confidence interval; OR: Odds ratio.

Supplemental table 3: Sexual problems by mode of birth in participants with complete data.

	Only spontaneous births	Instrumental vaginal birth, ever	Only c-sections	Spontaneous VBAC	Instrumental VBAC	C-section after vaginal birth
One or more sexual problem(s), n=32 638						
Cases (%)	7 615 (37)	1 643 (38)	1 144 (42)	651 (37)	177 (44)	1 043 (39)
Crude OR (95% CI)	Reference	1.03 (0.96–1.10)	1.21 (1.12–1.32)	1.00 (0.90–1.10)	1.34 (1.10–1.64)	1.10 (1.01–1.20)
Adjusted OR* (95% CI)	Reference	1.02 (0.95–1.09)	1.16 (1.07–1.26)	1.00 (0.90–1.10)	1.34 (1.10–1.64)	1.09 (1.00–1.18)
Reduced desire, n=33 360						
Cases (%)	4 547 (22)	956 (21)	644 (23)	395 (22)	100 (24)	602 (22)
Crude OR (95% CI)	Reference	0.99 (0.92–1.07)	1.07 (0.97–1.17)	1.02 (0.91–1.14)	1.17 (0.93–1.47)	1.03 (0.94–1.14)
Adjusted OR* (95% CI)	Reference	0.99 (0.92–1.07)	1.03 (0.94–1.13)	1.02 (0.91–1.14)	1.17 (0.93–1.47)	1.02 (0.93–1.13)
Difficulty in obtaining orgasm, n=32 915						
Cases (%)	2 621 (13)	590 (13)	377 (14)	233 (13)	69 (17)	361 (13)
Crude OR (95% CI)	Reference	1.07 (0.97–1.18)	1.08 (0.96–1.22)	1.04 (0.90–1.20)	1.43 (1.10–1.85)	1.08 (0.96–1.21)
Adjusted OR* (95% CI)	Reference	1.06 (0.96–1.16)	1.03 (0.92–1.16)	1.04 (0.90–1.20)	1.42 (1.09–1.84)	1.07 (0.95–1.21)
Insufficient lubrication, n=33 033						
Cases (%)	1 551 (7)	351 (8)	310 (11)	126 (7)	39 (10)	272 (10)
Crude OR (95% CI)	Reference	1.07 (0.95–1.21)	1.55 (1.36–1.76)	0.94 (0.79–1.13)	1.31 (0.94–1.83)	1.40 (1.22–1.60)
Adjusted OR* (95% CI)	Reference	1.00 (0.89–1.13)	1.40 (1.23–1.60)	0.95 (0.79–1.14)	1.23 (0.88–1.72)	1.35 (1.18–1.55)
Dyspareunia, n=33 140						
Cases (%)	1 858 (9)	407 (9)	417 (15)	164 (9)	48 (12)	282 (10)
Crude OR (95% CI)	Reference	1.03 (0.92–1.16)	1.79 (1.60–2.00)	1.03 (0.87–1.21)	1.36 (1.00–1.84)	1.19 (1.05–1.36)
Adjusted OR* (95% CI)	Reference	1.05 (0.93–1.17)	1.76 (1.57–1.98)	1.04 (0.88–1.23)	1.39 (1.02–1.89)	1.16 (1.02–1.33)
Entry dyspareunia, n=32 645						
Cases (%)	573 (3)	148 (3)	219 (8)	67 (4)	21 (5)	101 (4)
Crude OR (95% CI)	Reference	1.23 (1.02–1.48)	3.04 (2.59–3.57)	1.37 (1.06–1.77)	1.93 (1.24–3.02)	1.38 (1.11–1.71)
Adjusted OR* (95% CI)	Reference	1.19 (0.99–1.43)	2.81 (2.38–3.32)	1.37 (1.06–1.77)	1.89 (1.20–2.95)	1.36 (1.09–1.68)
Deep dyspareunia, n=32 645						
Cases (%)	1 308 (6)	253 (6)	206 (8)	96 (5)	29 (7)	182 (7)
Crude OR (95% CI)	Reference	0.91 (0.79–1.04)	1.20 (1.03–1.40)	0.84 (0.68–1.04)	1.15 (0.79–1.69)	1.08 (0.92–1.27)
Adjusted OR* (95% CI)	Reference	0.94 (0.82–1.09)	1.21 (1.04–1.42)	0.85 (0.69–1.06)	1.21 (0.82–1.77)	1.05 (0.89–1.24)

*Adjusted for maternal age at first birth, calendar year at first birth, pre-pregnant body mass index, socio-occupational status, self-assessed health, disease, exercise in pregnancy, and smoking in pregnancy.

C-section: Caesarean section; CI: Confidence interval; OR: Odds ratio; VBAC: Vaginal birth after caesarean section.

Supplemental table 4: Sexual problems by degree of perineal tear in participants with complete data.

	No tear/first degree	Second degree	Episiotomy	Anal sphincter tear
One or more sexual problem(s), n=25 655				
Cases (%)	5 434 (37)	1 430 (38)	2 086 (36)	644 (37)
Crude OR (95% CI)	Reference	1.04 (0.96–1.12)	0.95 (0.89–1.01)	1.00 (0.90–1.10)
Adjusted OR* (95% CI)	Reference	1.03 (0.95–1.11)	0.95 (0.89–1.02)	0.98 (0.89–1.09)
Reduced sexual desire, n=26 194				
Cases (%)	3 247 (22)	859 (23)	1 228 (21)	382 (22)
Crude OR (95% CI)	Reference	1.03 (0.94–1.12)	0.94 (0.87–1.01)	0.99 (0.88–1.11)
Adjusted OR* (95% CI)	Reference	1.01 (0.93–1.11)	0.95 (0.88–1.02)	0.98 (0.87–1.10)
Difficulty in obtaining orgasm, n=25 861				
Cases (%)	1 852 (13)	512 (14)	749 (13)	244 (14)
Crude OR (95% CI)	Reference	1.09 (0.98–1.21)	1.02 (0.93–1.12)	1.13 (0.98–1.30)
Adjusted OR* (95% CI)	Reference	1.07 (0.96–1.19)	1.02 (0.93–1.11)	1.11 (0.96–1.28)
Insufficient lubrication, n=25 945				
Cases (%)	1 051 (7)	286 (8)	437 (8)	146 (8)
Crude OR (95% CI)	Reference	1.06 (0.93–1.22)	1.05 (0.93–1.18)	1.18 (0.99–1.42)
Adjusted OR* (95% CI)	Reference	1.08 (0.94–1.24)	1.00 (0.89–1.12)	1.16 (0.97–1.40)
Dyspareunia, n=26 028				
Cases (%)	1 348 (9)	340 (9)	519 (9)	160 (9)
Crude OR (95% CI)	Reference	0.98 (0.86–1.11)	0.96 (0.87–1.07)	1.00 (0.84–1.18)
Adjusted OR* (95% CI)	Reference	0.98 (0.86–1.11)	0.98 (0.88–1.09)	1.01 (0.85–1.20)
Entry dyspareunia, n=25 670				
Cases (%)	415 (3)	103 (3)	187 (3)	65 (4)
Crude OR (95% CI)	Reference	0.97 (0.78–1.20)	1.14 (0.96–1.36)	1.33 (1.02–1.74)
Adjusted OR* (95% CI)	Reference	0.97 (0.78–1.21)	1.12 (0.94–1.34)	1.31 (1.00–1.71)
Deep dyspareunia, n=25 670				
Cases (%)	954 (7)	245 (7)	326 (6)	101 (6)
Crude OR (95% CI)	Reference	1.00 (0.87–1.16)	0.85 (0.75–0.97)	0.89 (0.72–1.09)
Adjusted OR* (95% CI)	Reference	1.00 (0.86–1.15)	0.88 (0.77–1.00)	0.91 (0.74–1.13)

*Adjusted for maternal age at first birth, calendar year at first birth, pre-pregnant body mass index, socio-occupational status, self-assessed health, disease, exercise in pregnancy, and smoking in pregnancy. CI: Confidence interval; OR: Odds ratio.

Supplemental table 5: Exposures in participants and non-participants.

	Participants in			
	The DNBC*	The maternal follow-up	This study	One or more sexual problems†
Mode of birth, n (%)				
All	88 128	43 639	37 417	35 514
Only spontaneous births	54 728 (62)	27 440 (63)	23 608 (63)	22 496 (63)
Instrumental vaginal birth, ever	11 521 (13)	5 845 (13)	5 003 (13)	4 736 (13)
Only c-sections	8 386 (10)	3 895 (9)	3 244 (9)	3 014 (9)
Spontaneous VBAC	4 565 (5)	2 355 (5)	2 038 (5)	1 931 (5)
Instrumental VBAC	1 080 (1)	526 (1)	457 (1)	431 (1)
C-section after vaginal birth	7 848 (9)	3 578 (8)	3 067 (8)	2 906 (8)
Degree of perineal tear, n (%)‡				
All	67 516	33 889	29 253	27 864
No tear or first degree	38 625 (57)	19 094 (56)	16 404 (56)	15 682 (56)
Second degree	9 590 (14)	4 888 (14)	4 267 (15)	4 047 (15)
Episiotomy	15 025 (22)	7 662 (23)	6 615 (23)	6 274 (23)
Anal sphincter tear	4 276 (6)	2 245 (7)	1 967 (7)	1 861 (7)

*Women with a live- or stillbirth in the DNBC.

†The outcome with highest percentage of missing data.

‡Women with a vaginal birth and no birth prior to 1994.

C-section: Caesarean section; DNBC: Danish National Birth Cohort; VBAC: Vaginal birth after caesarean section.

Supplemental table 6: Frequent dyspareunia by mode of birth.

	Only sponta- neous births	Instrumental vagi- nal birth, ever	Only c-sections	Spontaneous VBAC	Instrumental VBAC	C-section after vaginal birth
Dyspareunia, n=36 266						
Cases (%)	415 (2)	97 (2)	166 (5)	30 (3)	13 (3)	74 (3)
Crude OR (95% CI)	Reference	1.10 (0.88–1.38)	3.06 (2.54–3.68)	0.84 (0.57–1.21)	1.63 (0.93–2.85)	1.39 (1.08–1.78)
Adjusted OR* (95% CI)	Reference	1.09 (0.87–1.36)	2.82 (2.32–3.41)	0.83 (0.57–1.21)	1.59 (0.90–2.78)	1.32 (1.02–1.69)
Entry dyspareunia, n=35 720						
Cases (%)	181 (1)	42 (1)	106 (4)	15 (1)	8 (2)	32 (1)
Crude OR (95% CI)	Reference	1.10 (0.78–1.54)	4.49 (2.36–3.51)	0.96 (0.57–1.63)	2.32 (1.13–4.73)	1.37 (0.94–2.00)
Adjusted OR* (95% CI)	Reference	1.02 (0.73–1.43)	3.92 (3.03–5.05)	0.95 (0.56–1.61)	2.17 (1.06–4.45)	1.32 (0.90–1.93)
Deep dyspareunia, n=35 720						
Cases (%)	263 (1)	63 (1)	73 (2)	18 (1)	8 (2)	44 (2)
Crude OR (95% CI)	Reference	1.14 (0.86–1.50)	2.10 (1.61–2.72)	0.79 (0.49–1.28)	1.58 (0.78–3.23)	1.30 (0.94–1.79)
Adjusted OR* (95% CI)	Reference	1.17 (0.89–1.55)	2.01 (1.53–2.64)	0.79 (0.49–1.28)	1.60 (0.78–3.27)	1.21 (0.88–1.67)

*Adjusted for maternal age at first birth, calendar year at first birth, pre-pregnant body mass index, socio-occupational status, self-assessed health, disease, exercise in pregnancy, and smoking in pregnancy.
 C-section: Caesarean section; CI: Confidence interval; OR: Odds ratio; VBAC: Vaginal birth after caesarean section.

Supplemental table 7: Participant Characteristics by Degree of Perineal Tear.

	Degree of perineal tear				
	All (n=29 253)	None or first (n=16 404)	Second (n=4 267)	Episiotomy (n=6 615)	Anal sphincter (n=1 967)
Age at first birth, n (%)					
<25	4 522 (15)	2 763 (17)	563 (13)	993 (15)	203 (10)
25–29	16 073 (55)	9 010 (55)	2 394 (56)	3 566 (54)	1 103 (56)
30–34	7 269 (25)	3 926 (24)	1 085 (25)	1 716 (26)	542 (28)
≥35	1 389 (5)	705 (4)	225 (5)	340 (5)	119 (6)
Socio-occupational status, n (%)*					
Low	1 623 (6)	939 (6)	227 (6)	367 (6)	90 (5)
Middle	9 094 (33)	5 065 (33)	1 367 (34)	2 081 (34)	581 (31)
High	16 804 (61)	9 459 (61)	2 421 (60)	3 748 (60)	1 176 (64)
Missing	1 732	941	252	419	120
Prepregnant BMI, n (%)*					
<18.5	1 169 (4)	661 (4)	120 (3)	320 (5)	68 (4)
18.5–24.9	19 579 (72)	11 142 (73)	2 731 (69)	4 401 (72)	1 305 (72)
25.0–29.9	4 801 (18)	2 573 (17)	823 (21)	1 066 (17)	339 (19)
≥30.0	1 654 (6)	923 (6)	280 (7)	340 (6)	111 (6)
Missing	2 050	1 105	313	488	144
Exercise in pregnancy, min/week, n (%)*					
None	16 147 (57)	8 981 (58)	2 345 (58)	3 735 (60)	1 086 (59)
1–180	9 112 (33)	5 120 (33)	1 372 (34)	2 008 (32)	612 (33)
>180	2 289 (8)	1 382 (9)	301 (7)	458 (7)	148 (8)
Missing	1 705	921	249	414	121
Smoking in pregnancy, n (%)*					
No smoking	22 390 (81)	12 437 (80)	3 304 (81)	5 096 (81)	1 553 (83)
Smoking cessation	2 461 (9)	1 415 (9)	395 (10)	488 (8)	163 (9)

Supplemental table 7: Participant characteristics by degree of perineal tear (continued).

	Degree of perineal tear				
	All (n=29 253)	None or first (n=16 404)	Second (n=4 267)	Episiotomy (n=6 615)	Anal sphincter (n=1 967)
Smoking	2 930 (11)	1 749 (11)	360 (9)	674 (11)	147 (8)
Missing	1 472	803	208	357	104
Self-assessed health, n (%)*					
Very good	15 564 (56)	8 814 (57)	2 265 (56)	3 472 (56)	1 013 (54)
Normal	11 408 (41)	6 357 (41)	1 677 (42)	2 569 (41)	805 (43)
Not so good	695 (3)	361 (2)	98 (2)	190 (3)	46 (2)
Missing	1 586	872	227	384	103
Presence of disease, n (%)**†					
No	16 450 (60)	9 049 (58)	2 511 (62)	3 713 (60)	1 177 (63)
Yes	11 109 (40)	6 428 (42)	1 518 (38)	2 484 (40)	679 (37)
Missing	1 694	927	238	418	111

*Percentage of non-missing values.

†Diseases that, according to the women, had been confirmed by a physician, including hypertensive disorders, diseases of the heart, thyroid, or musculoskeletal system, epilepsy, diabetes, gynaecological diseases, and mental illness.

BMI: Body mass index.

Supplemental table 8: Frequent dyspareunia by degree of perineal tear.

	No tear/first degree	Second degree	Episiotomy	Anal sphincter tear
Dyspareunia, n=28 398				
Cases (%)	296 (2)	80 (2)	116 (2)	37 (2)
Crude OR (95% CI)	Reference	1.04 (0.81–1.34)	0.98 (0.78–1.21)	1.05 (0.74–1.48)
Adjusted OR* (95% CI)	Reference	1.04 (0.81–1.34)	0.99 (0.80–1.23)	1.06 (0.75–1.50)
Entry dyspareunia, n=28 006				
Cases (%)	122 (1)	32 (1)	53 (1)	20 (1)
Crude OR (95% CI)	Reference	1.02 (0.69–1.50)	1.09 (0.78–1.50)	1.38 (0.86–2.22)
Adjusted OR* (95% CI)	Reference	1.01 (0.68–1.50)	1.05 (0.76–1.46)	1.32 (0.82–2.13)
Deep dyspareunia, n=28 006				
Cases (%)	199 (1)	55 (1)	67 (1)	24 (1)
Crude OR (95% CI)	Reference	1.07 (0.79–1.45)	0.84 (0.63–1.11)	1.01 (0.66–1.55)
Adjusted OR* (95% CI)	Reference	1.08 (0.80–1.47)	0.87 (0.66–1.15)	1.09 (0.71–1.67)

*Adjusted for maternal age at first birth, calendar year at first birth, pre-pregnant body mass index, socio-occupational status, self-assessed health, disease, exercise in pregnancy, and smoking in pregnancy.
CI: Confidence interval; OR: Odds ratio.

Supplemental table 9: Sexual problems by mode of birth in women who had their first birth in the DNBC.

	Only sponta- neous births	Instrumental vag- inal birth, ever	Only c-sections	Spontaneous VBAC	Instrumental VBAC	C-section after vaginal birth
One or more sexual problem(s), n=17 587						
Cases (%)	4 069 (38)	920 (39)	865 (41)	342 (39)	90 (46)	517 (40)
Crude OR (95% CI)	Reference	1.07 (0.98–1.18)	1.17 (1.06–1.28)	1.04 (0.90–1.19)	1.43 (1.08–1.90)	1.10 (0.98–1.24)
Adjusted OR* (95% CI)	Reference	1.07 (0.98–1.18)	1.15 (1.04–1.27)	1.04 (0.90–1.20)	1.43 (1.08–1.91)	1.09 (0.97–1.23)
Reduced desire, n=17 941						
Cases (%)	2 466 (22)	541 (23)	500 (23)	211 (23)	52 (26)	295 (22)
Crude OR (95% CI)	Reference	1.02 (0.92–1.13)	1.05 (0.94–1.17)	1.05 (0.90–1.24)	1.22 (0.89–1.68)	1.00 (0.87–1.15)
Adjusted OR* (95% CI)	Reference	1.02 (0.92–1.14)	1.04 (0.93–1.17)	1.06 (0.90–1.24)	1.22 (0.89–1.68)	0.98 (0.86–1.13)
Difficulty in obtaining orgasm, n=17 730						
Cases (%)	1 397 (13)	332 (14)	285 (13)	131 (15)	33 (17)	176 (14)
Crude OR (95% CI)	Reference	1.11 (0.98–1.27)	1.05 (0.92–1.21)	1.16 (0.96–1.41)	1.37 (0.94–2.00)	1.06 (0.90–1.26)
Adjusted OR* (95% CI)	Reference	1.11 (0.97–1.26)	1.04 (0.91–1.20)	1.16 (0.96–1.41)	1.38 (0.94–2.01)	1.06 (0.89–1.25)
Insufficient lubrication, n=17 784						
Cases (%)	738 (7)	173 (7)	220 (10)	55 (6)	21 (11)	124 (10)
Crude OR (95% CI)	Reference	1.09 (0.92–1.29)	1.59 (1.35–1.86)	0.90 (0.68–1.19)	1.65 (1.04–2.61)	1.44 (1.18–1.76)
Adjusted OR* (95% CI)	Reference	1.03 (0.87–1.23)	1.38 (1.17–1.62)	0.91 (0.68–1.20)	1.64 (1.03–2.60)	1.45 (1.19–1.77)
Dyspareunia, n=17 840						
Cases (%)	995 (9)	230 (10)	312 (15)	82 (9)	28 (14)	157 (12)
Crude OR (95% CI)	Reference	1.07 (0.92–1.25)	1.71 (1.49–1.96)	1.00 (0.79–1.27)	1.65 (1.10–2.48)	1.35 (1.13–1.62)
Adjusted OR* (95% CI)	Reference	1.09 (0.93–1.26)	1.69 (1.47–1.94)	1.00 (0.79–1.27)	1.68 (1.12–2.53)	1.31 (1.09–1.57)
Entry dyspareunia, n=17 573						
Cases (%)	300 (3)	80 (3)	158 (8)	33 (4)	11 (6)	54 (4)
Crude OR (95% CI)	Reference	1.24 (0.97–1.60)	2.87 (2.36–3.51)	1.35 (0.93–1.94)	2.09 (1.13–3.88)	1.52 (1.13–2.04)
Adjusted OR* (95% CI)	Reference	1.20 (0.93–1.54)	2.56 (2.08–3.14)	1.35 (0.93–1.95)	2.06 (1.11–3.83)	1.52 (1.13–2.04)
Deep dyspareunia, n=17 573						
Cases (%)	721 (7)	151 (6)	160 (8)	50 (6)	18 (9)	182 (8)
Crude OR (95% CI)	Reference	0.97 (0.81–1.16)	1.16 (0.97–1.39)	0.83 (0.62–1.12)	1.42 (0.87–2.32)	1.27 (1.03–1.57)
Adjusted OR* (95% CI)	Reference	1.00 (0.83–1.20)	1.21 (1.01–1.45)	0.84 (0.62–1.12)	1.48 (0.90–2.42)	1.21 (0.98–1.50)

*Adjusted for maternal age at first birth, calendar year at first birth, pre-pregnant body mass index, socio-occupational status, self-assessed health, disease, exercise in pregnancy, and smoking in pregnancy. C-section: Caesarean section; CI: Confidence interval; DNBC: Danish National Birth Cohort; OR: Odds ratio; VBAC: Vaginal birth after caesarean section.

Supplemental table 10: Sexual problems by degree of perineal tear in women who had their first birth in the DNBC.

	No tear/first degree	Second degree	Episiotomy	Anal sphincter tear
One or more sexual problem(s), n=15 496				
Cases (%)	3 251 (38)	1 087 (39)	1 120 (37)	480 (39)
Crude OR (95% CI)	Reference	1.03 (0.95–1.13)	0.94 (0.87–1.03)	1.01 (0.90–1.14)
Adjusted OR* (95% CI)	Reference	1.04 (0.95–1.13)	0.94 (0.86–1.02)	1.02 (0.90–1.15)
Reduced sexual desire, n=15 794				
Cases (%)	1 971 (23)	650 (23)	655 (21)	289 (23)
Crude OR (95% CI)	Reference	0.99 (0.90–1.10)	0.91 (0.82–1.00)	1.00 (0.87–1.15)
Adjusted OR* (95% CI)	Reference	1.00 (0.90–1.11)	0.91 (0.82–1.01)	1.01 (0.88–1.16)
Difficulty in obtaining orgasm, n=15 610				
Cases (%)	1 108 (13)	386 (14)	402 (13)	173 (14)
Crude OR (95% CI)	Reference	1.07 (0.95–1.22)	1.01 (0.90–1.15)	1.08 (0.91–1.28)
Adjusted OR* (95% CI)	Reference	1.07 (0.95–1.21)	1.01 (0.89–1.14)	1.08 (0.91–1.28)
Insufficient lubrication, n=15 656				
Cases (%)	572 (7)	208 (7)	224 (7)	107 (9)
Crude OR (95% CI)	Reference	1.12 (0.95–1.32)	1.10 (0.94–1.29)	1.31 (1.05–1.62)
Adjusted OR* (95% CI)	Reference	1.11 (0.94–1.31)	1.07 (0.91–1.25)	1.27 (1.03–1.58)
Dyspareunia, n=15 705				
Cases (%)	834 (10)	261 (9)	269 (9)	128 (10)
Crude OR (95% CI)	Reference	0.94 (0.82–1.09)	0.89 (0.77–1.03)	1.05 (0.87–1.28)
Adjusted OR* (95% CI)	Reference	0.95 (0.82–1.10)	0.89 (0.77–1.03)	1.08 (0.89–1.32)
Entry dyspareunia, n=15 494				
Cases (%)	247 (3)	78 (3)	102 (3)	51 (4)
Crude OR (95% CI)	Reference	0.96 (0.74–1.24)	1.16 (0.92–1.46)	1.43 (1.04–1.94)
Adjusted OR* (95% CI)	Reference	0.95 (0.73–1.23)	1.13 (0.90–1.43)	1.41 (1.03–1.92)
Deep dyspareunia, n=15 494				
Cases (%)	603 (7)	191 (7)	172 (6)	82 (7)
Crude OR (95% CI)	Reference	0.96 (0.81–1.14)	0.78 (0.66–0.93)	0.92 (0.73–1.17)
Adjusted OR* (95% CI)	Reference	0.97 (0.82–1.15)	0.79 (0.66–0.94)	0.97 (0.76–1.22)

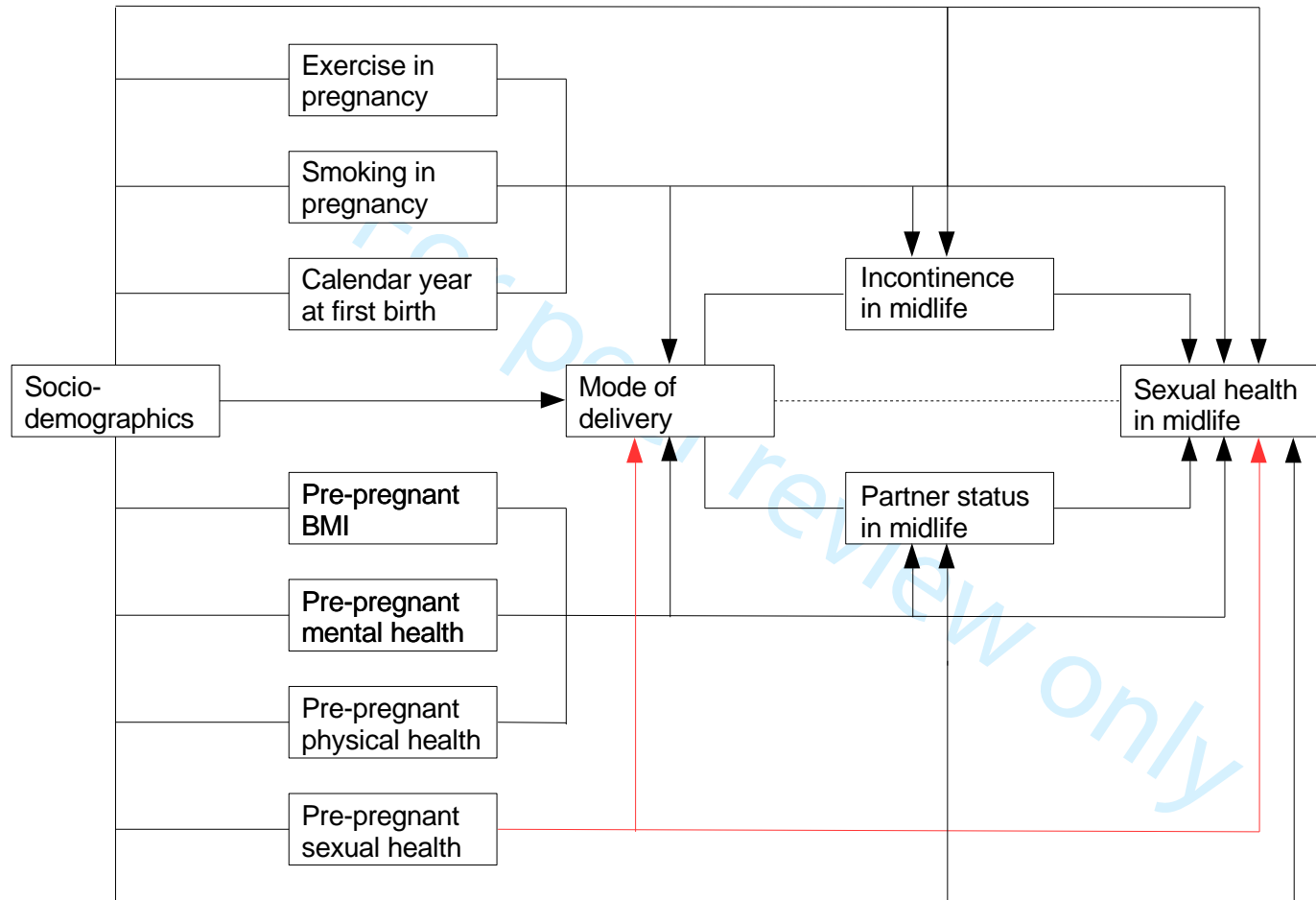
*Adjusted for maternal age at first birth, calendar year at first birth, pre-pregnant body mass index, socio-occupational status, self-assessed health, disease, exercise in pregnancy, and smoking in pregnancy.
CI: Confidence interval; DNBC: Danish National Birth Cohort; OR: Odds ratio.

Supplemental table 11: Sexual problems by mode of birth in participants without vaginismus.

	Only sponta- neous births	Instrumental vagi- nal birth, ever	Only c-sections	Spontaneous VBAC	Instrumental VBAC	C-section after vaginal birth
One or more sexual problem(s), n=35 343						
Cases (%)	8 196 (37)	1 759 (37)	1 229 (41)	705 (37)	185 (43)	1 119 (39)
Crude OR (95% CI)	Reference	1.02 (0.96–1.09)	1.21 (1.12–1.31)	1.00 (0.91–1.11)	1.33 (1.10–1.61)	1.10 (1.02–1.20)
Adjusted OR* (95% CI)	Reference	1.02 (0.95–1.08)	1.17 (1.08–1.27)	1.00 (0.91–1.11)	1.33 (1.09–1.61)	1.09 (1.01–1.18)
Reduced desire, n=36 139						
Cases (%)	4 917 (22)	1 034 (21)	702 (23)	431 (22)	103 (24)	639 (22)
Crude OR (95% CI)	Reference	0.99 (0.92–1.07)	1.08 (0.99–1.18)	1.03 (0.93–1.15)	1.13 (0.90–1.41)	1.02 (0.93–1.11)
Adjusted OR* (95% CI)	Reference	0.99 (0.92–1.07)	1.04 (0.95–1.14)	1.03 (0.92–1.15)	1.13 (0.90–1.41)	1.00 (0.91–1.10)
Difficulty in obtaining orgasm, n=35 650						
Cases (%)	2 822 (13)	631 (13)	406 (13)	252 (13)	71 (17)	390 (13)
Crude OR (95% CI)	Reference	1.06 (0.97–1.16)	1.08 (0.97–1.21)	1.04 (0.91–1.20)	1.39 (1.07–1.80)	1.09 (0.97–1.22)
Adjusted OR* (95% CI)	Reference	1.05 (0.96–1.16)	1.05 (0.94–1.18)	1.04 (0.91–1.20)	1.38 (1.07–1.79)	1.08 (0.97–1.21)
Insufficient lubrication, n=35 777						
Cases (%)	1 663 (7)	370 (8)	318 (11)	131 (7)	42 (10)	290 (10)
Crude OR (95% CI)	Reference	1.05 (0.94–1.18)	1.48 (1.30–1.67)	0.91 (0.76–1.09)	1.35 (0.98–1.87)	1.39 (1.22–1.59)
Adjusted OR* (95% CI)	Reference	0.99 (0.88–1.12)	1.36 (1.19–1.55)	0.89 (0.74–1.08)	1.28 (0.92–1.77)	1.35 (1.18–1.54)
Dyspareunia, n=35 894						
Cases (%)	1 958 (9)	431 (9)	432 (14)	160 (8)	51 (12)	301 (10)
Crude OR (95% CI)	Reference	1.04 (0.93–1.16)	1.75 (1.56–1.96)	0.94 (0.80–1.12)	1.40 (1.04–1.89)	1.22 (1.07–1.38)
Adjusted OR* (95% CI)	Reference	1.06 (0.95–1.18)	1.73 (1.54–1.94)	0.95 (0.80–1.12)	1.42 (1.06–1.92)	1.18 (1.04–1.35)
Entry dyspareunia, n=35 352						
Cases (%)	613 (3)	153 (3)	223 (8)	60 (3)	21 (5)	109 (4)
Crude OR (95% CI)	Reference	1.19 (0.99–1.42)	2.88 (2.46–3.38)	1.14 (0.87–1.49)	1.84 (1.18–2.88)	1.40 (1.13–1.72)
Adjusted OR* (95% CI)	Reference	1.15 (0.96–1.37)	2.71 (2.30–3.19)	1.14 (0.87–1.49)	1.80 (1.15–2.82)	1.38 (1.12–1.70)
Deep dyspareunia, n=35 352						
Cases (%)	1 367 (6)	269 (6)	222 (8)	98 (5)	32 (8)	195 (7)
Crude OR (95% CI)	Reference	0.93 (0.81–1.06)	1.24 (1.07–1.44)	0.82 (0.66–1.01)	1.25 (0.87–1.80)	1.12 (0.96–1.30)
Adjusted OR* (95% CI)	Reference	0.96 (0.84–1.10)	1.25 (1.07–1.45)	0.83 (0.67–1.03)	1.29 (0.90–1.87)	1.08 (0.93–1.27)

*Adjusted for maternal age at first birth, calendar year at first birth, pre-pregnant body mass index, socio-occupational status, self-assessed health, disease, exercise in pregnancy, and smoking in pregnancy. C-section: Caesarean section; CI: Confidence interval; OR: Odds ratio; VBAC: Vaginal birth after caesarean section.

Supplemental figure 1: Directed acyclic graph



The red arrows represent unadjusted confounding from pre-pregnant sexual health. The dotted line represents the study question. BMI: Body mass index.

STROBE Statement—Checklist of items that should be included in reports of *cohort studies*

	Item No	Recommendation	Page No
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract (b) Provide in the abstract an informative and balanced summary of what was done and what was found	1 2-3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up (b) For matched studies, give matching criteria and number of exposed and unexposed	6 Not applicable
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	4-6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	4
Bias	9	Describe any efforts to address potential sources of bias	6-7
Study size	10	Explain how the study size was arrived at	6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6-7
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding (b) Describe any methods used to examine subgroups and interactions (c) Explain how missing data were addressed (d) If applicable, explain how loss to follow-up was addressed (e) Describe any sensitivity analyses	7 7 7 Not applicable 7
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed (b) Give reasons for non-participation at each stage (c) Consider use of a flow diagram	6 and figure 1 6 Figure 1
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders (b) Indicate number of participants with missing data for each variable of interest (c) Summarise follow-up time (eg, average and total amount)	8-9 Table 1 and supplement 8
Outcome data	15*	Report numbers of outcome events or summary measures over time	Table 2 and 3

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3	Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included
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6			(b) Report category boundaries when continuous variables were categorized
7			(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
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10	Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
11			
12			
13	Discussion		
14	Key results	18	Summarise key results with reference to study objectives
15	Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
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17			
18	Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
19			
20	Generalisability	21	Discuss the generalisability (external validity) of the study results
21			
22	Other information		
23	Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based
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*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at <http://www.strobe-statement.org>.