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Mode of delivery and subsequent reproductive patterns. A national follow-up study

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Key words
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Abstract

Objective. To investigate associations between mode of delivery and subsequent reproductive outcomes. *Design.* Cohort study. *Population.* Women with term singleton live births from 1987 to 2009. *Setting.* Denmark, birth registration data. *Methods.* Women with a first singleton delivery after 37 weeks were followed until the end of 2010, from a first birth to include subsequent live births. We used Cox's proportional hazards model stratified by parity to compare the likelihood for subsequent delivery according to mode of delivery at first and later births, estimating maternal age effects and lag time to next delivery. *Main outcome measure.* Likelihood of a subsequent live-born child by previous delivery mode. *Results.* We identified 642 052 women with a first delivery. Compared with women with a non-instrumental vaginal delivery, delivering a child by elective cesarean section implied a 23% (95% CI 0.76–0.787) decreased likelihood for subsequent delivery. Emergency cesarean section meant 16% fewer (95% CI 0.84–0.85), and vaginal instrumental delivery 4% fewer subsequent deliveries (95% CI 0.95–0.96). Hazard ratios were largely unchanged after controlling for parity and year of birth. Small age-trends were seen, with hazard ratios affected by maternal age at birth. Delivery mode at first birth affected marginally the time lag until next birth. *Conclusions.* Fecundity, measured as likelihood of a successive live-born child, varied with mode of delivery at the first and also subsequent births. A first or later delivery by cesarean section implied decreased likelihood of subsequent delivery compared with women with a first vaginal birth.

Abbreviations: CI, confidence intervals; CS, cesarean section; HR, hazard ratio.

Key Message

Mode of delivery influences the likelihood of subsequent childbirth. Normal vaginal delivery was associated with the highest likelihood of having another child, while a lower likelihood was associated with instrumental vaginal delivery, emergency and elective cesarean section in that order. Among women with more than one subsequent delivery, time until a next birth varied only marginally by delivery mode and by maternal age at first birth.

Introduction

The effect of mode of delivery on subsequent fecundity is incompletely assessed. Most attention has been paid to the effect of cesarean section (CS), since rates of abdominal delivery have been increasing worldwide (1). Hemminki et al. observed that women who had their first child by CS subsequently had reduced fecundity (2). Several investigators have replicated their results and suggested

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that cesarean delivery has in some way a negative impact on reproduction compared with vaginal delivery (3–6). Some authors suggest the reduced fecundity to be voluntary or psychological (4,7,8), whereas others have considered it at least in part involuntary or of physical origin (2,9), i.e. somehow being a result of the surgery itself. CS can lead to adhesions, infection and placental bed disruption (2,10,11). Preexisting problems may also contribute (9). From a large national registry-based study Tollånes et al. deducted that reduced fecundity after CS was to a large degree voluntary and related to neither the indication nor the physical consequences of the surgical procedure (4). From a questionnare study Bhattacharya et al. concluded that not conceiving after a first birth was mainly voluntary, irrespective of the mode of delivery (8). Another relatively small study suggested that 42% of women who delivered their first baby by CS had no further children within 5 years compared with 29% after a normal vaginal birth (6). The trends seen in the large Norwegian study also concurred with this (4). The likelihood of having another child and the lag time to the next child are two markers of reduced fecundity (9).

Whether mode of delivery influences subsequent reproduction is useful population information as a guidance for healthcare staff and women. Light is also shed on the consequences of the currently high and widely increasing rates of elective cesarean delivery in many parts of the world (12,13). Apart from Tollånes et al. (4) all the relevant studies have, however, been of a limited size. A large national database provided us with the possibility to distinguish differences between the four principal methods of delivery, i.e. normal and instrumental vaginal delivery, elective and emergency CS, and to investigate the association between mode of delivery at first and later births and subsequent fecundity, as well as time until a next birth among those delivering more than once.

Material and methods

The Danish National Birth Registry was established in 1973 and contains information about all hospital and home births in Denmark, including information about the mother and children born, their unique personal identification number, pregnancy complications, the birth itself, its outcome and delivery complications. To obtain information on these parameters for a large cohort, the inclusion period was chosen to begin in 1987, since registration was of a poorer quality before this year. Before access to the data was obtained, the personal identification numbers were encrypted. By Danish law anonymized register studies do not require ethical committee approval, but the National Board of Health's Research Service (J.no. 7-505-29-1908/1) and the Danish Data Protection Agency approved the study (J.no. 2011-41-6756).

Cohort

Figure 1 shows an overview of the study population with the number of and reasons for excluded observations. Of singleton live births between 1 January 1987 and 31 December 2010, we included women who had their first live-born child at term (37–42 weeks by ultrasound estimation and, if required, menstrual dates) during the period 1 January 1987 to and including 31 December 2009 to secure at least 1 year of follow up. Women who had twins or other higher-order births at some point in their reproductive career were not included, because this may influence the decision on further childbearing. Mothers with stillbirths were likewise considered a specific group and excluded, as were preterm deliveries and those without information about mode of delivery or parity. Parity was defined as number of live-born children. To obtain a more homogenous cohort, births to women with parity >4 were excluded. Mothers entered into the delivery risk set at age 15 and left by age 45. This meant that if a mother had a child recorded in the National Birth Registry before she was 15 years old this birth was excluded

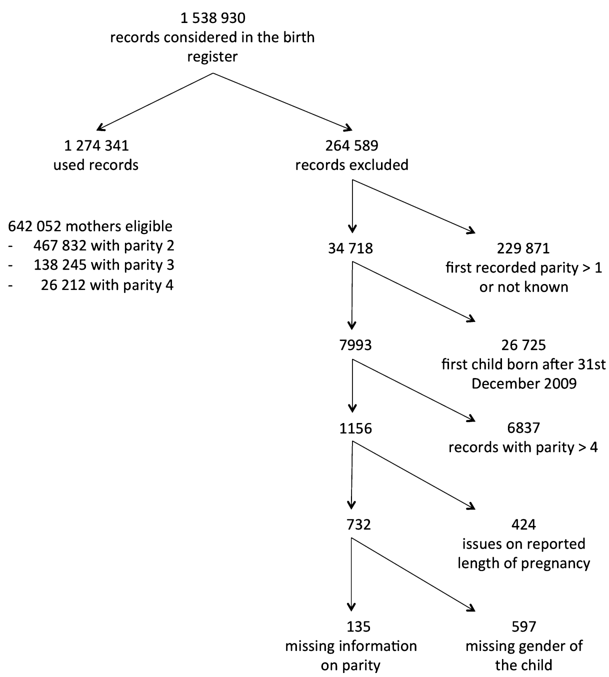

Figure 1. Study population showing total number of live births considered among 642 052 mothers in Denmark having a first child 1987–2009, with parity distribution. Cases/birth registration records not used with reasons for exclusion are also shown.

from analyses. Such a mother's subsequent children after she reached 15 years of age were included in the analyses with '15' as the start age of her at-risk period for a subsequent child. Any birth by a mother older than 45 years of age was also excluded. All waiting times to subsequent births were censored at age 45. Table S1 contains summary statistics comparing included and excluded mothers.

Variables and outcomes

The main outcome was likelihood of having a subsequent live-born child/children by mode of delivery, both after the first and a later birth. A Cox regression analysis provided time to subsequent delivery or to censoring (whichever came first), using maternal age as the time scale (14). Models were stratified according to parity and we used the four different delivery methods, normal vaginal, instrumental vaginal, emergency cesarean and elective cesarean delivery, respectively, as covariates (or "treatment" variables). "Normal vaginal" included induced and spontaneous-onset deliveries. We used hazard ratios (HR) to compare the likelihood of having a subsequent delivery among these categories, adjusted for maternal age. Normal vaginal delivery was chosen as the reference (HR = 1). HR <1 thus indicates a decreased likelihood of having a subsequent child and HR >1 a higher likelihood of a subsequent live-born child, primarily after the first, but also analysed by mode of delivery after a later birth(s).

Statistical analysis

We included the three covariates of maternal age, calendar time and mode of delivery separately into Cox models with time since last birth as the time scale. The age of the mother at both first and subsequent births was grouped into 5-year intervals, as was year of birth as calendar time. All Cox regression analyses were performed in R using the COXPH package. R is an integrated suite of software facilities for data manipulation, calculation and graphical display (http://www.r-project.org/). Due to the size of the data collected, we were not able to take into account the interdependence of observations originating from the same mother to adjust the standard error of the risk estimates. However, it is important to emphasize that HRs were not affected by whether or not we performed accounting for interdependence of observations. Conducting the analyses on a smaller subset of the data (the first 250 000 unique identification numbers) with and without taking the interdependence into account revealed virtually no differences between the standard errors of the HRs.

We performed repeated Cox analyses on maternal age sub-grouped into ±1.5-year intervals in the following way. We selected mothers who were 18 ± 1.5 years when giving birth, then ran the Cox model and saved the result. We then selected mothers who were (18 + 0.1) ± 1.5 years of age when giving birth, ran the Cox model and saved the result. This procedure was performed repeatedly, and the last group of mothers to be analyzed were those of age 42 ± 1.5 years when giving birth (=effective

Table 1. Summary statistics by parity for included deliveries in Denmark 1987–2009.

Parity	Mode of delivery	*N*	Mean age at birth (years)	SD age at birth (years)	Mean gestation period (days)	SD gestation period (days)	Mean weight (g)	SD weight (g)	Percent boys	Percent having at least one other child later on
Para 1	Normal vaginal birth	431 089	27.1	4.4	278.1	21.7	3 376	525	49.5	75.7
	Instrumental vaginal delivery	96 430	28.2	4.5	281.3	19.2	3 515	509	56.8	72.8
	Elective cesarean section	31 862	29.3	4.9	266.5	25.4	2 979	804	48.5	58.8
	Emergency cesarean section	82 671	28.8	4.8	275.6	25.5	3 356	791	55.3	63.8
Para 2	Normal vaginal birth	384 357	30.0	4.2	279.3	19.5	3 570	527	50.8	31.1
	Instrumental vaginal delivery	15 215	31.3	4.2	281.3	18.6	3 687	535	60.1	25.7
	Elective cesarean section	37 012	31.7	4.3	268.8	20.0	3 270	741	50.3	19.5
	Emergency cesarean section	31 248	31.3	4.4	272.1	24.6	3 425	819	54.9	23.8
Para 3	Normal vaginal birth	114 966	32.1	4.1	279.7	16.8	3 624	551	50.9	20.0
	Instrumental vaginal delivery	2076	33.7	3.9	281.3	16.4	3 717	557	63.2	15.0
	Elective cesarean section	14 165	33.2	4.0	267.8	16.4	3 240	730	50.0	11.9
	Emergency cesarean section	7038	32.9	4.2	267.0	24.6	3 289	863	55.0	16.6
Para 4	Normal vaginal birth	21 856	33.2	4.2	278.8	16.3	3 592	597	50.9	20.8
	Instrumental vaginal delivery	284	34.9	4.0	281.5	11.1	4 049	539	65.9	13.7
	Elective cesarean section	2583	34.3	4.0	267.2	15.5	3 157	667	50.2	10.5
	Emergency cesarean section	1489	34.0	4.3	264.0	24.2	3 367	866	53.7	13.7

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Table 2. Cox model by parity for mode of delivery as covariate.

Parity	Mode of delivery	Mothers	Births	Mean years at risk[a]	Total years at risk[b]	Hazard Ratio	Lower 95% confidence limit	Upper 95% confidence limit	*Z*-value	*p*-value
Para 1	Normal vaginal birth	431 089	326 156	4.6	1 989 835					
	Instrumental vaginal delivery	96 430	70 160	4.8	460 516	0.961	0.953	0.969	−9.53	<0.001
	Elective cesarean section	31 862	18 741	5.2	165 564	0.765	0.753	0.776	−35.67	<0.001
	Emergency cesarean section	82 671	52 704	4.9	407 906	0.838	0.831	0.846	−37.50	<0.001
Para 2	Normal vaginal birth	384 357	119 635	7.3	2 806 074					
	Instrumental vaginal delivery	15 215	3917	7.3	110 408	0.914	0.885	0.943	−5.56	<0.001
	Elective cesarean section	37 012	7220	6.2	227 703	0.791	0.773	0.810	−19.30	<0.001
	Emergency cesarean section	31 248	7446	6.6	207 383	0.890	0.870	0.911	−9.74	<0.001
Para 3	Normal vaginal birth	114 966	23 018	6.7	765 561					
	Instrumental vaginal delivery	2076	311	6.4	13 330	0.902	0.807	1.009	−1.80	0.0712
	Elective cesarean section	14 165	1685	5.8	82 156	0.711	0.677	0.747	−13.52	<0.001
	Emergency cesarean section	7038	1165	6.1	42 719	0.936	0.883	0.993	−2.20	0.0277
Para 4	Normal vaginal birth	21 856	4550	5.7	125 595					
	Instrumental vaginal delivery	284	39	5.3	1517	0.858	0.626	1.176	−0.95	0.3425
	Elective cesarean section	2583	270	5.3	13 777	0.594	0.525	0.671	−8.33	<0.001
	Emergency cesarean section	1489	204	5.3	7821	0.758	0.659	0.872	−3.87	<0.001

[a]The average time between birth of two subsequent children or, if no later children were born, censoring.
[b]The sum of all mothers' time between birth of two subsequent children or, if no later children were born, censoring.

censoring by age 42). Kaplan–Meier estimate curves were made of the time to second birth or for censoring in maternal age groups at first birth according to mode of delivery at first birth.

Results

The final cohort of 642 052 mothers with a first singleton birth during the study period was followed for at least 1 year, and in total 1 274 341 live births to these mothers were included in the analyses. Table 1 contains summary statistics for the included deliveries. Women having elective CS had the lowest percentage of a later delivery in all parity categories, followed by emergency CS and instrumental vaginal delivery. Mean age went up from 27 to 29 years at first birth to 33–35 years at a fourth birth. Table 2 shows that results were similar among women of different parities when analyzed by maternal age at birth and by calendar year, suggesting that these items influenced only modestly any detected effects on mode of delivery in a subsequent pregnancy. A simpler Cox analysis with summarized parities 1–4, confirmed the significantly lower likelihood ratios for later delivery after emergency and elective CS at any parity, while for instrumental vaginal delivery this was more marginal. The results did not change appreciably if analysis was restricted to women with only one subsequent child after the first delivery (see Table S2).

Table 3 shows HRs for having a subsequent birth according to mode of previous delivery when all parities were combined. We found that women who gave birth by elective CS had a 23% decreased likelihood (or an HR of 0.77, 95% CI 0.77–0.77) of delivering a subsequent child, compared with if the previous birth was a normal vaginal

Table 3. Cox model for mode of delivery stratified by total parity for the mothers (para 1–4).

Mode of delivery	Mothers	Births	Mean years at risk[a]	Total years at risk[b]	Hazard Ratio	95% lower and upper confidence limits		*p*-value
Normal vaginal birth	952 268	473 359	6.0	5 687 065	1	Reference		
Instrumental vaginal delivery	114 005	74 427	5.1	585 770	0.956	0.948	0.963	<0.001
Elective cesarean section	85 622	27 916	5.7	489 201	0.765	0.756	0.774	<0.001
Emergency cesarean section	122 446	61 519	5.4	665 829	0.842	0.835	0.849	<0.001

[a]The average time between birth of two subsequent children or, if no later children were born, censoring.
[b]The sum of all mothers' time between birth of two subsequent children or, if no later children were born, censoring.

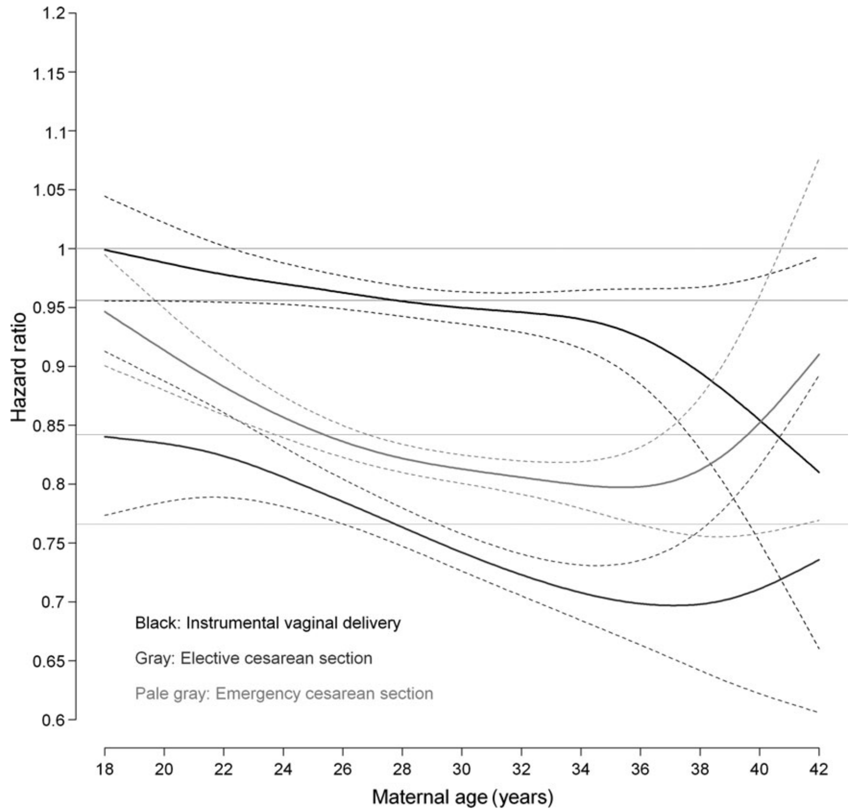

Figure 2. Effect of age on hazard ratios for subsequent birth relative to a spontaneous vaginal delivery: Figure constructed by performing repeated Cox analyses on age subgroups as shown on the horizontal axis ±1.5 years moving the "age window" 0.1 years for each new analysis. Data include first through to fourth parity (treated as strata) and delivery method as covariate: Fully drawn lines are hazard ratio estimates while broken lines are 95% confidence limits.

delivery. Elective CS was associated with the lowest fecundity in all age groups. This result was consistent across all parities and no substantial cohort effect was detected. The delivery lag for women with CS was smaller for younger than for older mothers (Figure 2). The instrumental vaginal group had an HR of further deliveries of 0.96 (95% CI 0.95–0.96) and the emergency CS group an HR of 0.84 (95% CI 0.84–0.85) when compared with the normal (non-instrumental) vaginal group.

One of the assumptions behind the Cox model is constancy of HRs across the time scale covered by the model. Specifically, this indicates that effects of the different delivery methods relative to normal vaginal birth were the same in younger and older mothers. Figure 2 shows the effect of maternal age on the relative risk (HR) of a particular mode of operative delivery against the baseline of normal delivery. There were fewer subsequent deliveries with advancing age up to around 35–40 years age. For mothers <34 years there was a trend for increased risk of not having a subsequent child as age increased (HR fell), for all modes of delivery compared with normal vaginal delivery. Confidence intervals widened at each end of the reproductive spectrum due to fewer observations.

Figure 3 shows the effect of maternal age and mode of delivery on the probability of having a second child (shown only for parity 1 for clarity). Age groups under 30 years had the highest likelihood of subsequent birth as expected, but the Kaplan–Meier estimates for combinations of maternal age group and mode of delivery at first birth showed no major differences between the four modes of delivery. The effect of maternal age on mode of delivery at first birth was small.

Discussion

Operative abdominal delivery, particularly an elective CS, was associated with fewer subsequent children. This was consistent across different parities and could not be attributed to a time trend nor to an age trend of note. The lag to a new childbirth among the women delivering their first or even a later child by CS increased with increasing age, although this influence was relatively weak. The HR for subsequent delivery fell with advancing

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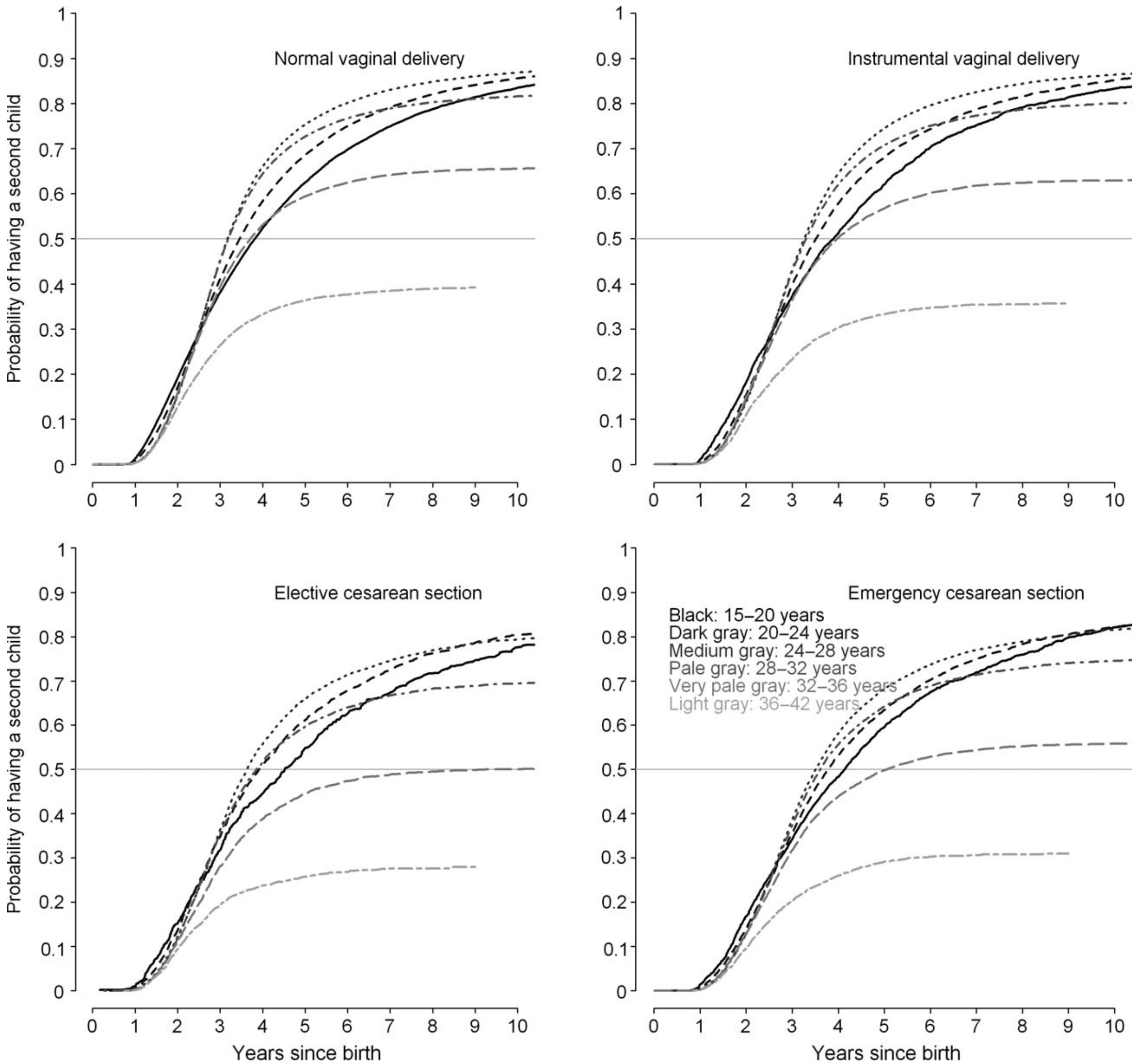

Figure 3. Kaplan–Meier estimates of time to second birth or censoring in age groups at first birth by mode of delivery at first birth.

age for all groups as shown in Figure 2, but more after instrumental delivery and especially elective CS. This is in line with the results of Jolly et al. who found a difference in subsequent delivery rates of 13% between women undergoing CS and those women having a vaginal delivery (6). Gottwall and Waldenström found that a negative birth experience was associated with fewer subsequent deliveries (15). A traumatic birth may make a woman reluctant to go through the experience again and so she may settle for one child only or for no further childbirth (stillbirth would be an exception (4)). Intuitively, an emergency cesarean can also be perceived as a more traumatic and exhausting experience, possibly traumatic enough to make the woman postpone a second pregnancy and childbirth longer than if the birth had been normal. However, elective CSs were associated with even lower subsequent fecundity than the emergency ones in the present study, irrespective of age. Therefore, it may be surmised that the reduced fecundity after an elective CS was probably and to a considerable extent due to factors related to the indication for the CS, which also is in line with the findings in the Norwegian material where reduced fertility after CS was partly confounded by indication, but also thought to be related to age, and with that possible changes in fertility, in part voluntary (4). Both CS groups in the present study had a procedure-related lowered fecundity. It may further have an effect that average parity in Denmark is rather low (http://data.worldbank.org/indicator/SP.POP.GROW), with most women not having more than two childbirths. Hence, most of the data presented in Table 1 pertain to two successive deliveries and this explains to a large extent the minimal differences found in the Cox analysis for mode of delivery after first birth and all subsequent deliveries after that, and what was found when we only considered the first and second births.

Tollånes et al. suggested that the reduced fertility was to a large degree voluntary and not related to the indication or to a physical consequence of the cesarean delivery, partly based on higher fecundity among women who had a stillbirth (4). As our aim was to investigate what happens when a woman delivers her singleton living child at term, when normal delivery might beforehand be expected, we could not address this. This may be considered a drawback and a source of bias, but from the study of Tollånes et al. (4) the effects would still be marginal as stillbirth or neonatal/infant deaths are fortunately rare events in this population. Tollånes et al. considered only vaginal birth and CS, whereas we distinguished between four modes of delivery. The difference observed between the two CS types could indicate both involuntary and/or indication-related factors as determining future fecundity among the emergency and particularly elective CS women. Women who have elective CS may also be less fertile than women who have normal vaginal births. Alternatively, women who have struggled with infertility may be more likely to be delivered by CS (confounding by indication). Zabeena et al. found that preexisting subfertility elevated the risk of obstetric complications, including CS (16).

Age was linked to mode of delivery in our population, but had a marginal effect (Figure 2), making it less likely that more advanced age at the time of a first child, or infertility related to this, were underlying factors for the lower fecundity after CS. The follow-up was sufficiently long, except for the last few observation years, to ensure that most women would have delivered again had they wished to do so. The shorter follow up in the last 3–5 years may have introduced bias because most women take longer than a year to reproduce again, but in numerical terms this effect may not have been large. For the whole study population the follow-up time was a mean of around 5 years (Tables 2 and 3). The lag time to a subsequent birth was not different between the delivery modes and this also makes infertility less likely among the women having elective CS. Comparable lag times may reflect voluntary and complex decision-making regarding the number of children which the woman eventually has. Bhattacharya et al. found in a questionnaire study on 409 women that women who had elective CS were more likely to avoid or to delay another pregnancy than those having an emergency procedure (8). They suggested that in women with one previous child, the subsequent absence of conception was mainly voluntary, irrespective of the type of previous delivery, which may to some extent contrast with our interpretation, but our study was not designed to address the background or indication factors nor reasons for reproductive decisions among the women. Tollånes et al. have shown in additional analyses of their material how the situation is complicated by the indications (17) and even educational levels (18) and sibship experiences (19).

The strength of this study was the inclusion of all women delivering live singleton babies in Denmark during the study period. Thereby selection bias was minimized with a consequent high external validity. The large number of observations ensured power in the analyses, as seen in narrow confidence intervals. A weakness was that the indication for the CS or physiological and psychological factors associated with the surgical procedure itself could not be taken into account, nor could multiple pregnancy, preterm delivery, low birthweight or fertility treatment, or the loss of a child before or after birth, which may all affect the likelihood of having a subsequent pregnancy. Changes related to the term breech trial published during the study period (20) affected obstetric practice in many parts of the world, but not to the same extent in Denmark (21), where the CS rate among the 1–1.5% of babies at term presenting by breech increased by less than 15%. This will not have had a major impact on our findings. A further limitation was that we were not able to work with the “ideal measure of fertility”, because we did not have access to contraceptive data or data on pregnancies that ended in abortions or fetal loss. A theoretical statistical weakness was that since all singleton births per woman were included, the observations for each woman were not independent. However, the potential error related to this had negligible influence due to the size of the material, as we were able to ascertain.

We conclude that a normal or even instrumental vaginal delivery is followed by more subsequent deliveries than abdominal operative delivery, whereas among those who delivered more than once, no major differences in lag time to a second delivery were found between the different birth methods. The decreased rates of delivery after an abdominal operative delivery are of concern due to the currently high CS rates seen widely across the globe, even in low- and medium-income countries, where abdominal delivery rates frequently range from 25 to 35%, and even surpass 50% in some countries (12,13). In parts of the world, lower fecundity would be desirable, whereas in other countries a tendency to have one or at

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most two children may be a cause of concern. To this must be added the serious side-effects increasingly seen as a result of rising section rates, including an abnormally invasive placenta and the many-fold increased costs associated with abdominal operative delivery (22,23).

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References

1. Betran AP, Merialdi M, Lauer JA, Bing-Shun W, Thomas J, Van LP, et al. Rates of caesarean section: analysis of global, regional and national estimates. Paediatr Perinat Epidemiol. 2007;21:98–113.
2. Hemminki E, Graubard BI, Hoffman HJ, Mosher WD, Fetterly K. Cesarean section and subsequent fertility: results from the 1982 National Survey of Family Growth. Fertil Steril. 1985;43:520–8.
3. Clark EA, Silver RM. Long-term maternal morbidity associated with repeat cesarean delivery. Am J Obstet Gynecol. 2011;205(6 Suppl):S2–10.
4. Tollanes MC, Melve KK, Irgens LM, Skjaerven R. Reduced fertility after cesarean delivery: a maternal choice. Obstet Gynecol. 2007;110:1256–63.
5. Porter M, Bhattacharya S, van Teijlingen E, Templeton A. Does Caesarean section cause infertility? Hum Reprod. 2003;18:1983–6.
6. Jolly J, Walker J, Bhabra K. Subsequent obstetric performance related to primary mode of delivery. Br J Obstet Gynaecol. 1999;106:227–32.
7. Lai TH, Wu MH, Hung KH, Cheng YC, Chang FM. Successful pregnancy by transmyometrial and transtubal embryo transfer after IVF in a patient with congenital cervical atresia who underwent uterovaginal canalization during Caesarean section: case report. Hum Reprod. 2001;16:268–71.
8. Bhattacharya S, Porter M, Harrild K, Naji A, Mollison J, van Teijlingen E, et al. Absence of conception after caesarean section: voluntary or involuntary? BJOG. 2006;113:268–75.
9. Murphy DJ, Stirrat GM, Heron J. The relationship between Caesarean section and subfertility in a population-based sample of 14 541 pregnancies. Hum Reprod. 2002;17:1914–7.
10. Nielsen TF. Cesarean section: a controversial feature of modern obstetric practice. Gynecol Obstet Invest. 1986;21:57–63.
11. Hurry DJ, Larsen B, Charles D. Effects of postcesarean section febrile morbidity on subsequent fertility. Obstet Gynecol. 1984;64:256–60.
12. Gibbons L, Belizan JM, Lauer JA, Betran AP, Merialdi M, Althabe F. Inequities in the use of cesarean section deliveries in the world. Am J Obstet Gynecol. 2012;206:331. e1–19.
13. Knight M, Sullivan EA. Variation in caesarean delivery rates. BMJ. 2010;341:c5255.
14. Thiébaut AC, Bénichou J. Choice of time-scale in Cox's model analysis of epidemiologic cohort data: a simulation study. Stat Med. 2004;24:3803–20.
15. Gottvall K, Waldenstrom U. Does a traumatic birth experience have an impact on future reproduction? BJOG. 2002;109:254–60.
16. Pandian Z, Bhattacharya S, Templeton A. Review of unexlained infertility and obstetric outcome: a 10 year review. Hum Reprod. 2001;16:2593–7.
17. Daltveit AK, Tollånes MC, Pihlstrøm H, Irgens LM. Cesarean delivery and subsequent pregnancies. Obstet Gynecol. 2008;111:1327–34.
18. Tollanes MC, Thompson JM, Daltveit AK, Irgens LM. Cesarean section and maternal education; secular trends in Norway, 1967–2004. Acta Obstet Gynecol Scand. 2007;87:840–8.
19. Tollanes MC, Rasmussen S, Irgens LM. Cesarean section among relatives. Int J Epidemiol. 2008;37:1341–8.
20. Hannah ME, Hannah WJ, Hewson SA, Hodnett ED, Saigal S, Willan AR. Planned caesarean section versus planned vaginal birth for breech presentation at term: a randomised multicentre trial. Term Breech Trial Collaborative Group. Lancet. 2000;356:1375–83.
21. Hartnack Tharin JE, Rasmussen S, Krebs L. Consequences of the Term Breech Trial in Denmark. Acta Obstet Gynecol Scand. 2011;90:767–71.
22. Solheim KN, Esakoff TF, Little SE, Cheng YW, Sparks TN, Caughey AB. The effect of cesarean delivery rates on the future incidence of placenta previa, placenta accreta, and maternal mortality. J Matern Fetal Neonatal Med. 2011;24:1341–6.
23. Druzin ML, El-Sayed YY. Cesarean delivery on maternal request: wise use of finite resources? A view from the trenches. Semin Perinatol. 2006;30:305–8.

Supporting information

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

Table S1. Summary statistics comparing included and excluded mothers.

Table S2. Cox model for mode of delivery and age group at first childbirth (parity 1 only).