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A national register-based study

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Length of hospital stay after cesarean section in Denmark from 2004 to 2016: a national register-based study

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ABSTRACT

Introduction Length of hospital stay after birth has decreased during the last decades, but nationwide data on length of hospital stay after cesarean section are lacking. Elements of Enhanced Recovery Programs were reported to reduce the length of hospital stay. The aim of this nationwide study was to describe the length of hospital stay after cesarean section in Denmark from 2004 to 2016 taking into account birth- and health related factors as well as demographic changes and further, to assess potential differences between the five Danish regions. **Material and methods** Length of hospital stay was assessed in 164 209 deliveries by cesarean section in Denmark from 2004 to 2016. Data were obtained from the Danish National Patient Register. All deliveries by cesarean section at gestational age < 22 weeks were excluded. Median length of hospital stay was reported based on crude and adjusted analyses. **Results** The median length of hospital stay was significantly reduced by 39 hours (95% CI; 37.9 to 40.1) from 97 hours (4.0 days) in 2004 to 58 hours (2.4 days) in 2016. Reductions were observed among both planned and emergency cesarean sections. When birth- and health related factors as well as demographic changes were accounted for, median length of hospital stay was reduced by 30 hours (95% CI; 29.3 to 30.8) in the period. The decrease in length of hospital stay from 2004 to 2016 varied between the five Danish regions with adjusted reductions between 19 and 46 hours. **Conclusions** A nationwide decrease in length of hospital stay after cesarean section was observed from 2004 to 2016 across all five regions but with significant regional variations. Further studies on the optimal length of hospital stay are needed, especially with regard to implementation of enhanced recovery programs.

Keywords

Cesarean section, length of stay, postpartum period, postoperative care, patient discharge, enhanced recovery

Abbreviations

CS	cesarean section
ERAS	enhanced recovery after surgery
ICD	International Classification of Disease

LOS	length of hospital stay
CPAP	continuous positive airway pressure

Key message

Length of hospital stay after cesarean section was reduced from 4.0 to 2.4 days in Denmark from 2004 to 2016. Variations were observed between regions and reductions occurred for both emergency and planned cesarean section.

INTRODUCTION

In many countries, early discharge after birth has become routine and cesarean section (CS) is no exception.[1-5] Previous studies showed a reduced length of hospital stay (LOS) after CS by introducing elements of enhanced recovery after surgery (ERAS),[6-8] even with discharge the day after CS in some settings.[4,6,9] Still, large variations in LOS occur worldwide, i.e. the American College of Obstetricians and Gynecologists describes the usual LOS as 96 hours after CS.[10]

In the 1990s, Kehlet developed ERAS within colorectal surgery to optimize quality in the postoperative period,[11] and this multimodal approach in perioperative care has since been introduced in several surgical fields. Worldwide, CS is the most common major abdominal surgical procedure.[12] However, ERAS was introduced rather late in obstetrics compared to other specialties.[13] Single elements from other ERAS programs, such as early removal of urinary catheter and early mobilization, have been widely adapted to CS.[14,15] The ERAS society guidelines were first published on CS in 2018.[16,17] Therefore, the potential benefits from ERAS programs are probably not reached yet, and further improvement in quality and reductions in LOS are considered possible. However, a recent randomized trial comparing ERAS and routine care did not find any difference in proportion of patients discharged two days after planned CS, yet a small but significant reduction was observed in median LOS.[18]

Among 63 890 deliveries in Denmark in 2004, the CS rate was 20.5% (emergency CS 12.4%, planned CS 8.1%). In 2016, the CS rate among 61 695 deliveries was 19.5% (emergency CS 11.2%, planned CS 8.3%).[19] Danish hospitals follow the same national guidelines regarding CS, however, time of discharge is not included in the guidelines.[20] In 2001, a study showed a mean LOS of 4.7 days following CS in Denmark.[14] Twelve years later another Danish study from 2013 to 2014 reported a median LOS of approximately 2.7 days after CS.[2] However, both studies were based on small samples (N < 500). Unfortunately, no nationwide data have been published. Further, several factors such as parity, gestational age and obesity may affect LOS but nationwide data have not been reported.[2,21,22]

The aim of this study was to describe the development in LOS in Denmark after CS from 2004 to 2016 taking into account birth- and health related factors as well as demographic changes. Furthermore, we wanted to assess the differences in LOS between the Danish Regions.

MATERIAL AND METHODS

This register-based observational study is based on national data from the Danish National Patient Register, the Medical Birth Register and the Register of Education.[23,24] Data were accessed through Statistics Denmark. Information from the different registers was linked on a person-level using the unique number identifying each contact to the health care system and the date of CS.

We included women giving birth by CS in Denmark from January 1, 2004 to December 31, 2016. Women aged < 15 or > 49 years or women giving birth at gestational age < 22 weeks were excluded. All women with CS were identified by the procedure codes KMCA10A, KMCA10B, KMCA10D and KMCA10E. The procedure codes KMCA10A, KMCA10D and KMCA10E were categorized as emergency CS, and KMCA10B as planned CS. LOS was defined as the postoperative time in full hours from CS to discharge. We considered LOS < 0 hours occurring due to missing or misclassified data and consequently, women with LOS < 0 hours were excluded. Right-censoring was made at LOS of 28 days.

From the Danish National Patient Register, we retrieved information on maternal and neonatal morbidity. We defined obstetric morbidity as a woman having an obstetric diagnosis during the year of CS, including the following International Classification of Disease (ICD)-10 diagnoses: Gestational proteinuria (DO121), gestational hypertension (DO139), pre-eclampsia (DO140-141), HELLP syndrome (DO142), eclampsia (DO150), gestational diabetes mellitus (DO244D, DO244E), rhesus- or other isoimmunization (DO360-361), vasa or placenta previa (DO431E, DO449), placental abruption (DO459), uterine rupture (DO710A, DO710B, DO711AA, DO711AB) or prolapse of the umbilical cord (DO690). Further, we defined maternal morbidity as a woman having a medical diagnosis during a period of 10 years before CS, in concordance with categories of chronic and physical and mental health conditions defined according to Jølving et al..[25] These diagnoses included 23 categories of chronic physical and mental health conditions. Finally, neonatal morbidity was defined as the newborn child having at least one of the following

conditions; sepsis (ICD-10: DP36), use of ventilation or continuous positive airway pressure (CPAP) at the neonatal ward (procedure code: BGFC32, BGDA0), Apgar score < 7 at 5 minutes, or a malformation of which minor anomalies were excluded according to the European Network of Population-Based Registries for the Epidemiological Surveillance of Congenital Anomalies (EUROCAT) definition.[26] Sepsis and the use of ventilation or CPAP were registered within the first 180 days after delivery, whereas malformations registered within the first year after delivery was included.

From the Danish Medical Birth Register and the Register of Education we obtained information on several birth- and health related factors as well as educational level and other demographic factors. The 13-year study period was divided into three time periods: 2004 to 2007; 2008 to 2011 and 2012 to 2016. The women were allocated to one of the five Danish regions according to location of the hospital conducting the CS. Gestational age at birth was measured in weeks and days, and divided into five groups; 22^0 to 27^6; 28^0 to 33^6; 34^0 to 36^6; 37^0 to 41^6 and $\geq 42^0$ weeks. Maternal education was measured as the highest education attained and registered at the beginning of the year of CS and divided into five levels: 1: primary or upper secondary education; 2: vocational education and training and qualifying educational programs; 3: short cycle higher education and vocational bachelors education; 4: medium cycle higher education/bachelors programs and 5: long cycle higher education/masters or PhD programs. Maternal pre-pregnancy body mass index < 14 and ≥ 60 kg/m^2 were analyzed as missing to avoid inclusion of potentially incorrect registrations. Parity was divided into primiparous and multiparous women according to the status of the woman after CS. Maternal cigarette smoking was divided into smoking or no smoking during pregnancy. We categorized pregnancies as being either a singleton or multiple pregnancy.

Statistical analyses

LOS does not follow a normal distribution; therefore, median values are presented. Accordingly, the statistical method used was quantile regression with the year 2004 as the reference when analyzing changes in LOS. The crude LOS was adjusted for a priori covariates including maternal body mass index (continuous), gestational age (five categories), parity (primiparous or multiparous), maternal cigarette smoking (smoking or no smoking during pregnancy), multiple pregnancy (singleton or multiple pregnancy), type of CS (emergency or planned), maternal age

(continuous), maternal morbidity (yes/no), obstetrical morbidity (yes/no), neonatal morbidity (yes/no) and maternal education (five categories). Taking into account that each woman could contribute with more than one pregnancy robust variance estimates were used. A sensitivity analysis was performed excluding LOS < 6 hours and > 28 days in the analysis, to assess the robustness of the findings when excluding potentially misclassified measures of LOS. Non-parametric test for trend was used for comparison of categorical variables over time, while continuous variables were analyzed using one-way ANOVA. Results are presented as median LOS with 95% confidence intervals, interquartile ranges, 10^{th} and 90^{th} percentiles. Logistic regression analysis of discharge < 96 hours versus ≥ 96 hours after CS was performed (10, 27). A level of significance of $p < 0.05$ was used. Statistical analyses were conducted using STATA 15 (Stata Corp., College Station, TX, USA).

Ethical approval

The study was approved by Statistics Denmark (no. 707008, 8 January 2018). According to Danish law register-based studies do not require ethical approval.

RESULTS

During the study period from 2004 to 2016, a total of 164 721 women gave birth by CS in Denmark. We excluded 526 women due to LOS < 0 hours, gestational age < 22^0 weeks and maternal age < 15 years or > 49 years, leaving a total of 164 209 women in the final study population. Among them, 68 950 (42%) had a planned CS (Figure 1).

The study population was characterized by a mean maternal age of 31.3 years (SD 5.0) and a pre-pregnancy body mass index of 25.2 kg/m^2 (SD 5.4). Furthermore, 46.9% were primiparous, 10.2% were smokers, and 5.9% had a multiple pregnancy. Obstetric morbidity was present in 14.8%, and pre-pregnancy morbidity in 18.8%. During the study period a small but statistically significant increase was observed in maternal age and pre-pregnancy body mass index, and significantly more women had pre-pregnancy or obstetric morbidity when comparing 2004 and 2016. A decrease

over time was observed in the proportion of smokers. Missing data varied between 1.1% and 5.2% (Table 1).

The crude median LOS in the entire study population was reduced by 39 hours (95% CI; 37.9 to 40.1, $P < 0.001$) from 2004 to 2016, from 97 hours (95% CI; 96 to 97) in 2004 to 58 hours (95% CI; 57 to 59) in 2016. The 90th percentile LOS decreased from 170 hours (95% CI; 168 to 172) in 2004 to 124 hours (95% CI; 122 to 126) in 2016 (Figure S1). When adjusted for birth- and health related factors as well as demographic changes the median LOS was reduced by 30 hours (95% CI; 29.3 to 30.8, $p < 0.001$) from 2004 to 2016. The adjusted analysis was based on a total of 147 243 women (90%) with available data on all included factors (Table 2). Discharge < 96 hours after CS was performed in 48.6% of the women in 2004, while 81.4% were discharged < 96 hours in 2016. For discharge < 96 hours versus ≥ 96 hours, the OR was 4.63 (95% CI; 4.37 to 4.91), suggesting a substantialy increased chance of discharge < 96 hours at the end of the study period. No seasonal variation in LOS was observer (data not shown).

Median LOS decreased for both emergency and planned CS. For emergency CS, the crude median LOS was reduced with 34 hours from 99 hours (95% CI; 98 to 100) in 2004 to 65 hours (95% CI; 64 to 66) in 2016. For planned CS, the crude median LOS was reduced with 30 hours from 82 hours (95% CI; 80 to 93) to 52 hours (95% CI; 52 to 52) (Figure S2). Adjusted reductions were 33 hours (95% CI; 31.8 to 34.6) for emergency CS and 27 hours (95% CI; 26.8 to 28.0) for planned CS.

The crude median LOS varied between primi- and multiparous women during the entire study period. For primiparous women, the crude median LOS was reduced with 37 hours from 105 hours (95% CI; 104 to 107) to 68 hours (95% CI; 67 to 69). For multiparous women the crude median LOS was reduced with 28 hours from 80 hours (95% CI; 79 to 81) to 52 hours (95% CI; 52 to 52) (Figure S3). Adjusted reductions were 38 hours (95% CI; 36.9 to 39.7) for primiparous women and 26 hours (95% CI; 25.6 to 27.0) for multiparous women.

Median LOS decreased in all regions from 2004 to 2016, but the baseline LOS and the reduction in LOS differed significantly (Figure 2). In 2004, median LOS ranged between 78 hours (95% CI; 77 to 79) in the Capital Region of Denmark and 102 hours (95% CI; 101 to 104) in Central

Denmark Region. Reductions between 23 hours (95% CI; 21.5 to 24.5) and 48 hours (95% CI; 46.3 to 49.7) were observed in the period. Adjusted analyses showed reductions between 19 (95% CI; 17.3 to 20.0) and 46 hours (95% CI; 43.7 to 48.5, Table S1). The reductions were mainly observed from 2004 to 2009 (Figure 2).

When excluding LOS < 6 hours (n = 1733) and > 28 days (n = 438) in the sensitivity analyses, comparable results were found in the median and 90th percentile LOS. A reduction of 38 hours (95% CI; 37.1 to 38.9) in median LOS was observed ($p < 0.001$). In the adjusted analysis the reduction in median LOS was 30 hours (95% CI; 29.2 to 30.6, $p < 0.001$).

DISCUSSION

When factors related to birth, health and demography were accounted for, we found a reduction of 30 hours from 2004 to 2016 in median LOS after CS in Denmark. A decrease was seen across all five Danish regions but with large variability between the regions.

The actual LOS observed for different time periods correspond to the LOS reported by previous studies in Denmark as well as internationally.[2,14,28-30] A Danish study reported a mean LOS of nearly 5 days after CS in 2001,[14] whereas another Danish study found a median LOS of 2.7 days in 2013-2014.[2] However, the LOS in some countries is significantly longer.[3,31] Nevertheless, the tendency to decreasing LOS after CS is also described in other countries. A Canadian study compared the periods 2003-2005 and 2008-2010 and found that in the early period, 27% of women giving birth by CS were discharged within two days, and in the latest period 44% were discharged within two days after CS, which is comparable to our findings.[32] A significant decrease was also reported in an Italian study by Pertile et al. where the proportion of women being discharged within four days was 4% in 2006, rising to 52% in 2016. Pertile et al. also described significant differences between the regional maternity units.[5] Another Italian study, presenting several factors determining LOS after CS, also showed substantial variations in LOS between hospitals.[27]

The major strength of our study is the nationwide setting with data from the Danish National Patient Register, which is a comprehensive source and a valid tool for research.[23,24] Thus, data on all deliveries in Denmark were available, which implied a large study population consisting of 164 209 deliveries by CS, inherently with no selection bias. We were also able to assess the development in LOS for planned and emergency CS separately, and the study period of 13 years made it possible to study the effect of birth- and health related factors as well as demographic changes on LOS over time.

We a priori planned to stratify the main analyses by parity, type of CS, and region, but the aim of this paper was not to identify factors predicting LOS, and hence further analyses were not planned in order to avoid unnecessary risk of type 1 error. Furthermore, caution should be taken when interpreting studies based on register data. One important consideration in this study is the potential misclassification of the information used on CS as well as date and time of surgery and discharge. The registration of CS in the Danish National Patient Register has previously been shown to have high sensitivity and specificity,[23] although there was a discrepancy in the coding of the exact type of CS. However, in this study we only differentiated between two categories, either planned or emergency, thus increasing the accuracy of the information. The previous validation study is from 2003, and whether the results correspond to our study period is unknown.[23] Further, changes in the registration over time from 2004 to 2016 may have affected our findings. To what extent the time of CS and discharge are correctly registered remains uncertain. To account for some of the possible incorrect registration in LOS, a sensitivity analysis excluding LOS < 6 hours and LOS > 28 days was conducted and did not change our findings. Further, the practices of registration might have changed for some of the explanatory variables during the study period. In our data a decreasing proportion of missing values was observed regarding some variables such as maternal pre-pregnancy body mass index and smoking. Even so, since the proportion of missing values was small the results are not considered to have been affected.

We had the ability to adjust for several birth- and health-related factors and demographic changes, however, residual confounding may be present. Information on other factors such as interventions toward establishing breastfeeding or local procedures of discharge to other units was not included. Furthermore, economic factors in the health care system might have had an effect on the postnatal care being offered routinely after CS. These factors may help explain regional differences.

Another unaddressed perspective is the culture and expectations among patients as well as health care professionals, which may have affected the differences in LOS between regions and time periods. A wider acceptance of early discharge was previously suggested by Wrench et al., who observed a reduced LOS even before introducing all parts of an announced ERAS program.[6]

Another limitation of this study is that readmissions were not included. Previous studies on LOS and readmission are not comparable due to different definitions of early discharge, and the conclusions on its significance are conflicting. When LOS is reduced, some studies indicate an unaffected readmission rate[6,33] whereas others report an increased readmission rate with shorter LOS calling for further studies.[30,32,34]

The increased focus on ERAS is assumed to have affected the clinical routines after CS during the study period.[7,14,35] Several studies have demonstrated a reduced LOS induced by ERAS protocols.[4,6,8] However, to what extent the decreasing LOS is caused by a more widespread use of ERAS elements is uncertain, and as mentioned multiple other factors might have affected LOS in the period. A recent randomized trial found no increase in patients discharged day 2 after elective CS by providing ERAS.[18] However, they demonstrated a slightly significant reduction in median LOS from 75.5 to 73.5 hours. This supports the hypothesis that ERAS only partly explains the observed reduction in LOS over time.

We found that the magnitude of the reduction in LOS varied between the regions of Denmark. The region with the smallest reduction had the lowest LOS at the beginning of the observation period, and hence, a less pronounced decrease in absolute numbers might be expected. Furthermore, the largest reductions were observed in the beginning of the study period from 2004 to 2009. Likewise, as the reduction in LOS was less pronounced among women undergoing planned compared to emergency CS, and also less pronounced among multiparous compared to primiparous women, reductions in LOS might have taken place in these groups before 2004. Even though ERAS programs might seem more applicable to planned surgery, the tendency in reduced LOS might affect other groups as well, yet with a certain delay.

Our study presented the actual LOS, but the optimal LOS after CS is still debatable. Of major concern is the safety of the mother and the neonates, but the lower limit of LOS ensuring a safe

discharge remains unknown. Postpartum hemorrhage is the main complication jeopardizing maternal safety. However, studies suggest that relaparotomy due to postpartum hemorrhage occurs within 11 hours after CS.[36,37] As for neonatal safety it is estimated that in Denmark approximately 13% of neonates are admitted to the neonatal intensive care unit within 48 hours after planned CS.[38] A study from the UK showed that approximately 6% of neonates in 2014 were readmitted within 30 days after CS.[30] Jaundice is the primary indication in half of neonatal readmissions with no differences between modes of delivery.[32] This implies that breastfeeding has to be accounted for, but also other factors such as parental satisfaction and health care resources and organization should be considered when planning the postoperative period after CS.

Satisfaction among women giving birth in Denmark was reported in an annual nationwide survey from 2016.[39] The mothers were asked if they found the LOS too short, appropriate or too long. Among 1048 women giving birth by CS, 11.4% reported that the LOS was too short, whereas 9.3% reported that the LOS was too long. The results were comparable across the regions, even though the actual LOS differed between the regions. Cautious interpretation is needed due to small sample size, but there was no association between the patients' perception of an appropriate LOS and the actual LOS. On the other hand, a general increase in satisfaction was reported in relation to a shorter LOS implied by ERAS programs.[40] Yet, more information on patients' perceived readiness for discharge is needed.

Our results were obtained in Denmark, a country with approximately 5.8 million inhabitants, equal access to a government funded health care system and national guidelines regarding CS. Time of discharge is based on clinical assessment by health care professionals rather than based on economic incentives. For each CS performed, the hospitals receive a fixed amount of money, which covers the patient´s hospital stay lasting up to five days. Only if LOS exceeds five days, the payment is raised. Further, maternity care in all regions includes postpartum home visits from a nurse within the first week and visits at the general practitioner. Still, regional differences in LOS were substantial.

With an increased focus and evidence of enhanced recovery after CS, a potential for further improvement in quality of care as well as reduction in LOS is present.[4] Also, clinical audits of prolonged postoperative courses might reveal procedures requiring optimization. If LOS is further

reduced, i.e. by introducing routine discharge the day after CS unless contraindicated based on individual clinical assessment, organizational factors should be ensured such as easy access to the maternity ward and follow-up by the primary health care system. In addition, home visits could be considered provided by the hospital as previously suggested in national guidelines from the UK.[41]

CONCLUSION

A significant decrease in LOS after CS was observed in Denmark during the study period from 2004 to 2016. Variations of the decrease occurred when comparing the five Danish regions. Further studies on the postoperative care after CS are needed, especially with regard to the optimal LOS and implementation of enhanced recovery programs.

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Legends

Table 1. Characteristics of the study population, Denmark, 2004-2016.

Table 2. Reduction in the median length of hospital stay (LOS) in hours after cesarean section (both emergency and elective) in Denmark, 2004-2016.

Figure 1. Flowchart of the study population.

Figure 2. Crude median length of hospital stay (LOS) in hours after cesarean section in the five regions of Denmark, 2004-2016.

Supporting Information legends

Table S1. Median length of hospital stay (LOS) in hours after cesarean section in the five regions of Denmark, 2004-2016.

Figure S1. Crude length of hospital stay (LOS) in hours after cesarean section in Denmark, 2004-2016. The boxes depict the median and the interquartile range, and the whiskers the 10th and 90th percentiles.

Figure S2. Crude length of hospital stay (LOS) in hours after planned and emergency cesarean section in Denmark, 2004-2016. The boxes depict the median and the interquartile range, and the whiskers the 10th and 90th percentiles.

Figure S3. Crude length of hospital stay (LOS) in hours after cesarean section for primi- and multiparous women in Denmark, 2004-2016. The boxes depict the median and the interquartile range, and the whiskers the 10th and 90th percentiles.

	2004-2007		2008-2011		2012-2016		Total	
	n	%	n	%	n	%	N	%
Women giving birth by CS	52 558		52 000		59 651		164 209	
Planned CS	21 155	40.3	22 113	42.5	25 682	43.1	68 946	42.0
Emergency CS	31 403	59.8	29 887	57.4	33 969	57.0	95 249	58.0
Regions								
Capital Region of Denmark	18 181	34.6	17 994	34.6	21 328	35.8	57 503	35.0
Region Zealand	7169	13.6	6722	12.9	7246	12.2	21 137	12.9
Region of Southern Denmark	10 938	20.8	10 762	20.7	12 098	20.3	33 798	20.6
Central Denmark Region	12 011	22.9	11 781	22.7	13 471	22.6	37 263	22.7
North Denmark Region	4259	8.1	4741	9.1	5508	9.2	14 508	8.8
Maternal age, years (SD)	31.1 (4.8)		31.3 (5.0)		31.4 (5.2)		31.3 (5.0)	
Pre-pregnancy BMI, kg/m2 (SD)[b]	25.0 (5.3)		25.3 (5.5)		25.3 (5.5)		25.2 (5.4)	
Primiparous after index CS[b]	24 597	46.8	23 961	46.1	28 461	47.7	77 019	46.9
Smoking[b]	6 922	13.2	5 154	9.9	4 604	7.7	16 680	10.2
Gestational age at birth								
$22^0 – 27^6$	345	0.7	329	0.6	390	0.7	1064	0.7
$28^0 – 33^6$	2121	4.0	1975	3.8	2213	3.7	6309	3.8
$34^0 – 36^6$	4168	7.9	4008	7.7	4483	7.5	12 659	7.7
$37^0 – 41^6$	42 014	79.9	42 324	81.4	50 347	84.4	134 685	82.0
42^0 -	3910	7.4	3364	6.5	2218	3.7	9492	5.8
Multiple pregnancy[b]	3224	6.1	3114	6.0	3387	5.7	9725	5.9
Pre-pregnancy maternal morbidity	8135	15.5	9823	18.9	12 868	21.6	30 826	18.8
Obstetric morbidity	6647	12.7	7613	14.6	10 016	16.8	24 276	14.8
Neonatal morbidity	4212	8.0	4251	8.2	5309	8.9	13 772	8.4
Level of maternal education[b,c]								
Level 1	8349	15.9	7959	15.3	8639	14.5	24 947	15.2
Level 2	21 658	41.2	19 090	36.7	20 299	34.0	61 047	37.2
Level 3	2898	5.5	2978	5.7	3186	5.3	9062	5.5
Level 4	13 543	25.8	13 844	26.6	16 085	27.0	43 472	26.5
Level 5	5419	10.3	6756	13.0	9569	16.0	21 744	13.2

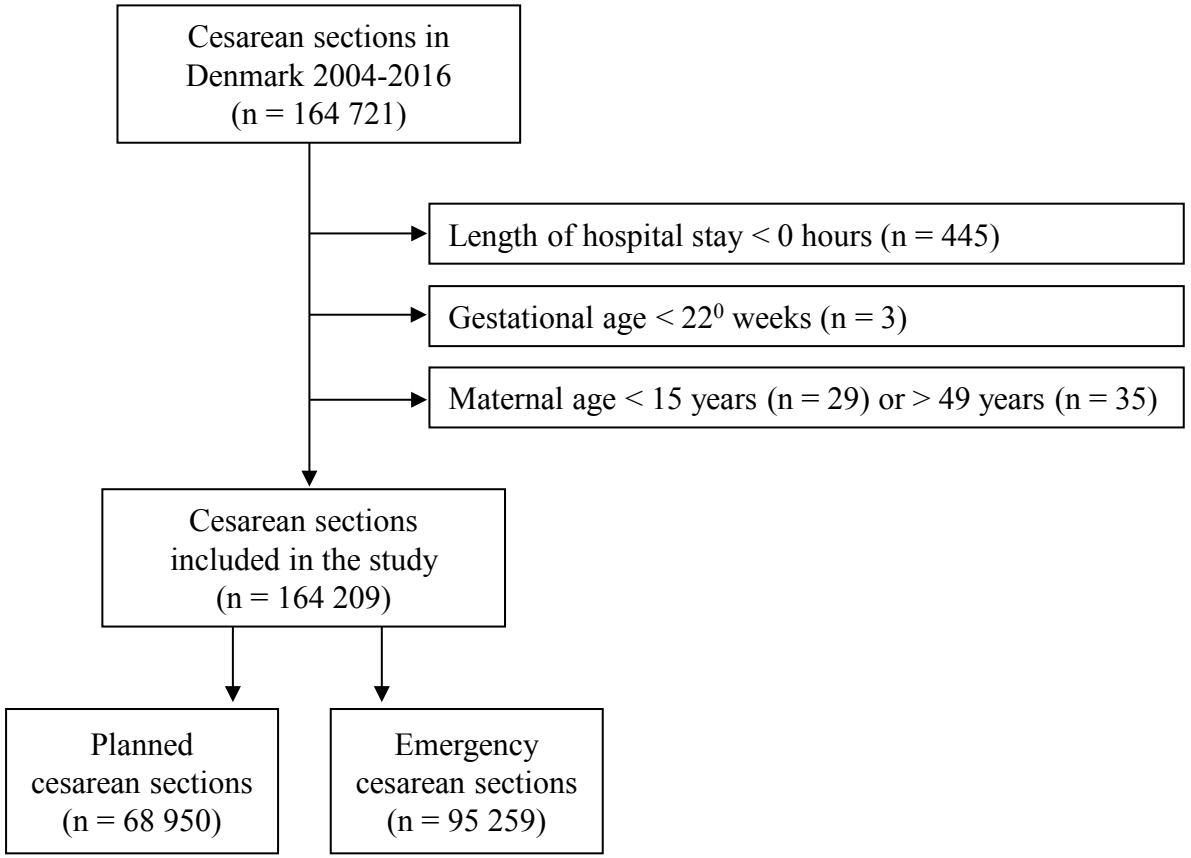
[a] Data are given as numbers and mean (SD = standard deviation), % is percentage of total number in column.

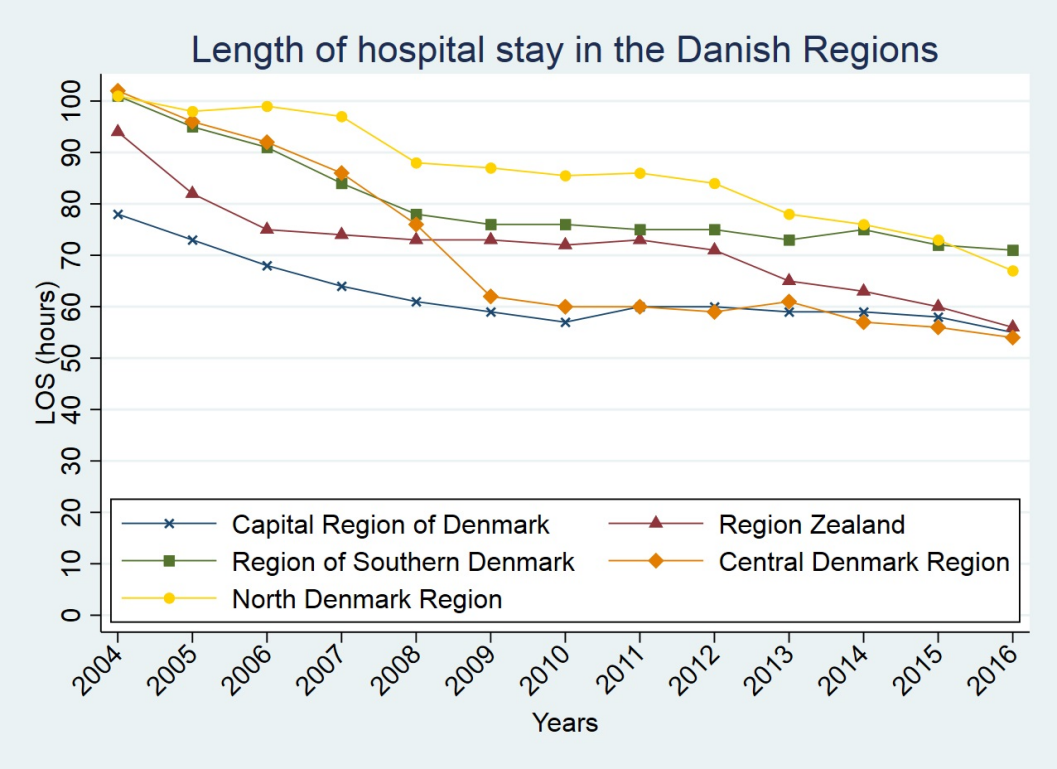
[b] Missing data regarding BMI in 8561 women (5.2%); parity in 3757 women (2.3%); smoking status in 5924 women (3.6%), fetal multiplicity in 1835 women (1.1%) and level of education in 3937 women (2.4%).

[c] Level of maternal education: Level 1: primary or upper secondary education; level 2: vocational education and training and qualifying educational programs; level 3: short cycle higher education and vocational/bachelors education; level 4: medium cycle higher education/bachelors programs and level 5: long cycle higher education/masters or PhD programs.

	Crude LOS	95% CI	Adjusted LOS[a]	95% CI
2004	Reference	Reference	Reference	Reference
2005	-14	-15.4 to -12.6	-7	-8.5 to -6.4
2006	-19	-20.0 to -18.0	-12	-13.2 to -11.0
2007	-21	-21.9 to -20.1	-17	-18.2 to -15.8
2008	-24	-24.9 to -23.1	-22	-22.5 to -20.5
2009	-27	-28.0 to -26.0	-24	-25.1 to -23.5
2010	-28	-29.2 to -26.8	-25	-25.8 to -24.3
2011	-28	-29.2 to -26.8	-25	-25.7 to -24.3
2012	-29	-30.2 to -27.8	-25	-26.2 to -24.7
2013	-32	-33.2 to -30.8	-26	-27.0 to -25.6
2014	-33	-34.2 to -31.8	-27	-27.7 to -26.2
2015	-35	-36.1 to -33.9	-28	-28.9 to -27.5
2016	-39	-40.1 to -37.9	-30	-30.8 to -29.3

[a] Adjusted for maternal BMI, maternal cigarette smoking, gestational age, parity, multiple pregnancy, type of cesarean section, maternal age, obstetric morbidity, pre-pregnancy maternal morbidity, neonatal morbidity and maternal education.





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