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Research Article

Do psychological factors predict caesarean delivery in Australia? A cohort study

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Abstract

Background: The proportion of babies delivered by Caesarean Section (CS) in Australia has almost doubled over the last 25 years. Factors known to contribute to CS such as higher maternal age, mothers being overweight or obese, or having had a previous CS do not completely account for the increased rate and it is clear that other influences exist. Our study used nationally-representative data from the Longitudinal Study of Australian Children (LSAC) to identify risk factors associated with CS, with a view to identifying previously unidentified influences.

Methods: Data were from the birth cohort of LSAC, a long-term prospective study of approximately 5,000 children that includes richly-detailed data regarding maternal health and exposures during pregnancy. Logistic regression was used to examine the contribution of a wide range of pregnancy, birth and social factors to CS.

Results: 28% of 4,862 mothers were delivered by CS. The final adjusted analyses revealed that use of diabetes medication (OR=3.1, 95% CI=1.7-5.5, p<0.001) and maternal mental health problems during pregnancy (OR=1.3, CI=1.1-1.6, p=0.003) were associated with increased odds of CS. Young maternal age (OR=0.6, CI=0.5-0.7, p<0.001), having two or more children (OR=0.7, CI=0.6-0.9, p<0.001), and fathers having an unskilled occupation (OR=0.7, CI=0.6-1.0, p=0.036) were associated with reduced odds of CS.

Conclusion: Our findings raise the prospect that screening and intervention programs for maternal mental health problems, and attention to diabetic control in pregnancy, might be beneficial in reducing CS rates and should be studied in appropriately-constructed prospective trials.

List of abbreviations

CS: Caesarean section, LSAC: Longitudinal study of Australian Children, MCMC: Markov Chain Monte Carlo

Background

The proportion of babies delivered by Caesarean Section (CS) in Australia currently exceeds 30%, a rate that has almost doubled over the last 25 years, although now appears to be reaching a plateau [1]. A similar trend has been noted around the world, in both developed and developing countries [2]. Despite the World Health Organization (WHO) withdrawing recommendations regarding a maximum rate of caesarean birth several years ago [3] there remains a consensus that the number of CS performed should represent a minimum commensurate with safety for mother and baby in both the short and long term [4-8]. Unfortunately, strategies aimed at reducing the rate of CS have had only modest success at best [6].

A number of socio-demographic factors are known to be associated with increased rates of CS. The strongest of these include increased maternal age, particularly at the time of first birth [9-12], as well as the mother being overweight or obese [8,13]. In addition, once CS has been performed, the most likely mode of delivery in subsequent pregnancy is CS [14-17] Higher socio-economic status and possession of private health insurance are also associated with higher rates of CS [18,19].

While maternal mental health status is not often examined as a predictor of CS, findings from two recent studies provide evidence that a history of prior psychiatric conditions or mental health problems reported during pregnancy are associated with increased rates of CS [20,21]. Although anxiety and fear of childbirth were commonly reported reasons for women requesting elective cesarean delivery in several international studies [16,22], fears of 'loss of control' and pain were found to be less commonly-reported motivating factors in Australia and maternal requests for CS probably represent only a small proportion of CS overall [23].

Even taking these risk factors into account, it is likely that other influences exist and are affecting the rate of CS [24]. Given that factors such as increased maternal age, obesity, and previous CS are difficult if not impossible to modify, it is important to be alert to other potentially-modifiable factors that might affect rates of CS. The aim of this study was to examine the importance of a range of pregnancy,

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birth, and family risk factors in predicting CS in Australia. This study used data from the Longitudinal Study of Australian Children (LSAC), a data-rich prospective cohort study of approximately 5000 Australian children and their families, in order to broaden evidence around CS in Australia.

Materials and methods

Dataset

The LSAC is a nationally-representative prospective cohort study of Australian children and their families [25]. Children were selected from Australia's universal health insurance database (Medicare) using a two-stage cluster sampling design. Of the contactable families selected, the families of 5107 infants (a 64% initial response rate) in the birth cohort commenced participation in 2004. Our study draws on data from wave one, when children were aged 0-1 years. Data were collected by face-to-face interview and self-report questionnaire by the parent who knew the child best, of which 98.6% were the child's biological mother. LSAC was approved by the Australian Institute of Family Studies Ethics Committee. Mothers were excluded from this current study if the pregnancy was complicated by breech presentation at birth (N=67), multiple birth (N=165), and where the mode of birth was unspecified (N=21) or missing (N=3), yielding a final sample of 4,862 mothers for analysis.

Measures

Data available included whether their child had been born preterm (<37 weeks), had been born with low birth weight (<2500 kg), or whether the child had required a ventilator or intensive care after birth. For data analysis in the current study, we collapsed mode of birth data to a binary variable (CS or vaginal). In the self-report questionnaire, mothers were asked a series of questions about the circumstances around the pregnancy and birth. These questions included whether they smoked or drank during pregnancy, whether they had taken a list of prescribed medication such as antibiotics, blood pressure tablets, or any 'over the counter' medicines during pregnancy, and whether the pregnancy had been complicated by hypertension and/or diabetes. All questions were answered with 'yes' or 'no' responses.

Data on social factors were also collected by face-to-face interview. Socio-economic position (SEP) was a continuous, composite variable that ranked each family's relative socio-economic position at the time of recruitment based on parental income, education and occupational prestige [26]. Families with a standardized score at or below the 25th percentile were classified as having a 'low' socio-economic position. Other characteristics of mothers and the family collected by parent-report at wave one included maternal age and education, single parent status, maternal and paternal employment, child Aboriginal and Torres Strait Islander status, number of children in the household, and whether English was the primary language spoken at home. Mothers were classified as having been born overseas if they were born outside of Australia or New Zealand. Geographic remoteness of the household was classified using the Accessibility/Remoteness Index of Australia [27].

Statistical analysis

Variables were analyzed in Stata version 13.1 [28] using the survey methods procedure to weight the analyses for participants' unequal probability of selection into the sample, and the multi-stage, clustered sampling design [29]. Data were imputed to handle missing data due to a lower completion rate of the leave-behind questionnaire compared to the face-to-face interview. Multivariate multiple imputation was performed using an iterative Markov Chain Monte Carlo (MCMC) method, with fully conditional specification (ICE 'chained' method). The augmented-regression option was used to handle perfect prediction, given the large number of categorical variables in our final models. The imputation model included all pregnancy, birth and social variables, with wave one sample weights and cluster variables (postcodes and strata) entered as 'regular' non-imputed variables into the imputation equation. Thirty imputations for each dataset were requested and successfully produced.

Logistic regression analyses were then undertaken to estimate the odds ratio and 95% confidence intervals for significant risk factors for CS. Three analysis steps were used to examine the associations between CS and each of the pregnancy, birth and social factors. In the first step, unadjusted (univariate) logistic regression analyses were performed with CS as the binary dependent variable and each of the pregnancy, birth and social factors as independent variables in the models. In the second step, adjusted models were run with significant variables ($p<0.1$) from step one in separate models for (a) the pregnancy and birth factors, and (b) the social factors. In the third step, final adjusted models were run grouping all significant factors ($p<0.1$) from step two.

Results

Of the 4862 mothers included in the final sample, 1374 (28.2%) gave birth by CS. Differences in pregnancy, birth and social characteristics for children born by CS compared to children born vaginally are reported in Table 1. A number of pregnancy factors were associated with CS in the unadjusted models. Maternal smoking in pregnancy was associated with lower odds for CS. The use of any prescribed medication, medication for diabetes or hypertension, 'heartburn,' or indeed any other over-the-counter medications was associated with increased odds for CS. Furthermore, maternal mental health problems, reported diabetes, and high blood pressure were also associated with increased odds of CS. All of the birth factors were associated with moderately increased odds, from close to 50% for preterm birth or low birth weight, up to 84% for child requiring ventilator support, and 91% for children admitted to intensive care after birth.

Two social factors were associated with increased odds for CS. Higher annual household income (per $10K increase) was associated with an 11% increase in odds for CS, while maternal age of 35 years or older, when compared to mothers aged 30-35 years at recruitment, was associated with 22% increased odds. In contrast, other social factors were associated with lower odds of CS. Maternal age less than 30 years, father working in an unskilled occupation, first language other than English, having two or more children in the household, fathers reporting a high educational level, and mother working in an unskilled occupation were all associated with decreased odds for CS.

Table 2 presents data from the first set of adjusted models split by (a) pregnancy and birth factors; and (b) social factors. In the first adjusted model, maternal smoking was the only factor associated with decreased odds of CS. Use of diabetes, heartburn and over-the-counter medications during pregnancy, maternal mental health problems, and child admission to intensive care, all continued to predict increased odds for CS. In the second adjusted model, annual household income and maternal age 35 years or older continued to predict high odds of CS. Younger maternal age, first language other than English, having two or more children in the household, and father's unskilled occupation predicted lower odds for CS.

Table 1: Pregnancy, birth and social characteristics for children born via caesarean section (CS) (*N*=1,374) and children born via vaginal birth (non-CS) (*N*=3,488).

	CS %	*Non-CS %*	*OR (95% CI)*	*p*
Pregnancy factors				
Maternal smoking in pregnancy	17	21	0.76 (0.62, 0.94)	0.011
Maternal alcohol use in pregnancy	34	37	0.90 (0.78, 1.04)	0.152
Use of any prescribed medication	34	29	1.26 (1.10, 1.46)	0.001
Use of antidepressant medication	3	2	1.26 (0.80, 1.96)	0.315
Use of antibiotic medication	11	10	1.00 (0.79, 1.27)	0.980
Use of asthma medication	4	4	0.94 (0.66, 1.34)	0.726
Use of diabetes medication	3	1	3.87 (2.30, 6.51)	<0.001
Use of nausea/sickness tablets	5	5	1.11 (0.81, 1.52)	0.501
Use of blood pressure tablets	3	2	1.87 (1.21, 2.89)	0.005
Use of iron tablets	6	7	0.88 (0.68, 1.13)	0.310
Use of heartburn medication	4	3	1.67 (1.22, 2.29)	0.001
Use of thyroid tablets	2	1	1.38 (0.82, 2.34)	0.227
Use of over-the-counter medication	86	83	1.24 (1.02, 1.50)	0.033
Maternal mental health problems in pregnancy	22	18	1.26 (1.06, 1.50)	0.008
Maternal diabetes in pregnancy	8	5	1.64 (1.23, 2.20)	0.001
Maternal high blood pressure in pregnancy	11	7	1.56 (1.19, 2.04)	0.001
Birth factors				
Child born preterm (<37 weeks)	7	5	1.49 (1.14, 1.94)	0.003
Child born with low birth weight (<2500 g)	6	4	1.53 (1.14, 2.06)	0.005
Child admitted to intensive care	23	14	1.91 (1.60, 2.27)	<0.001
Child needed ventilator support	7	4	1.84 (1.37, 2.46)	<0.001
Social factors				
Annual household income $10K AUD, mean (sd)	3.18 (0.08)	2.82 (0.05)	1.11 (1.07, 1.16)	<0.001
Language other than English	15	18	0.78 (0.63, 0.95)	0.014
Maternal age, mean (sd)	32.1 (0.2)	30.5 (0.2)	1.05 (1.04, 1.07)	<0.001
Mother less than 30 years	28	41	0.60 (0.51, 0.70)	<0.001
Mother 30-35 years	46	41	*Reference*	
Mother older than 35 years	26	18	1.22 (1.04, 1.43)	0.014
Single parent family	9	11	0.79 (0.61, 1.03)	0.081
2 or more children in household	57	61	0.82 (0.72, 0.94)	0.003
Primary parent born overseas	19	20	0.93 (0.78, 1.11)	0.432
Remote/very remote location	3	4	0.91 (0.52, 1.58)	0.730
Indigenous status	4	5	0.77 (0.53, 1.11)	0.162
Mother's education less than Year 12	42	43	0.96 (0.84, 1.10)	0.566
Father's education less than Year 12	43	48	0.82 (0.71, 0.95)	0.008
Mother unskilled occupation	21	25	0.81 (0.69, 0.97)	0.019
Father unskilled occupation	13	19	0.62 (0.48, 0.80)	<0.001

Note: OR (95% confidence interval) denotes odds ratio from unadjusted logistic regression analysis, with CS as the dependent variable.

Data from the final adjusted model are presented in Table 3. Factors in pregnancy or related to birth conveyed the highest odds of CS; these were use of diabetes medication, child admission to intensive care, use of heartburn medication, and maternal mental health problems during pregnancy. The social factors were maternal age greater than 35, and higher annual household income. Four social factors were associated with lower odds of CS: maternal age less than 30, families with two or more children, fathers with an unskilled occupation, and families speaking a language other than English at home.

Discussion

We sought to identify the birth, pregnancy and social factors associated with CS in a large representative cohort of Australian families. The rate of CS in the cohort was similar to the Australian national rate of 28.5% at the time of recruitment (the year 2004) (28.2% vs 28.5%, unadjusted OR 1.06, 95% CI 0.99, 1.13) [30]. Our findings were consistent with the well-recognized association between maternal age and CS. Women reporting use of medication for diabetes during pregnancy, another previously-reported risk factor for adverse pregnancy outcomes, and admission of child to intensive care after birth were also both associated with an increased likelihood of CS.

Our study is one of the first to examine the relationship between CS and a range of maternal and socio-economic factors simultaneously. The findings support previous research showing an association between pregnancy and social factors and rates of CS [9-12,18,19]. We found that the father's occupation was associated with CS - families with fathers in unskilled occupations were less likely to undergo CS. This association may well be a surrogate for access to private health insurance, since the rate of CS is, in general, lower in public hospitals [31]. Higher household income was associated with an increased likelihood of CS. Families with two or more children, or where a language other than English was used at home, were less likely to undergo a CS. Unexpectedly, the presence of maternal mental health problems during pregnancy increased the odds for CS.

The aim of this study was to identify early factors that might be

Table 2. Two adjusted models for (a) pregnancy and birth factors; and (b) social factors predicting odds of caesarean section (N=4,862).

	OR (95% CI)	***p***
Model 1: Pregnancy and birth factors		
Maternal smoking in pregnancy	0.72 (0.58, 0.89)	0.003
Use of any medication in pregnancy	1.10 (0.93, 1.29)	0.284
Use of diabetes medication	2.51 (1.36, 4.61)	0.003
Use of blood pressure tablets	1.04 (0.62, 1.77)	0.870
Use of heartburn medication	1.48 (1.05, 2.10)	0.026
Use of over-the-counter medication	1.28 (1.05, 1.55)	0.015
Maternal mental health problems in pregnancy	1.21 (1.01, 1.45)	0.039
Maternal diabetes in pregnancy	1.15 (0.82, 1.61)	0.432
Maternal high blood pressure in pregnancy	1.30 (0.94, 1.79)	0.113
Child born preterm (<37 weeks)	0.98 (0.69, 1.38)	0.891
Child born with low birth weight (<2500 g)	1.12 (0.77, 1.63)	0.538
Child admitted to intensive care	1.66 (1.34, 2.06)	<0.001
Child needed ventilator support	1.10 (0.77, 1.56)	0.613
Model 2: Social factors		
Annual household income	1.05 (1.01, 1.09)	0.021
Language other than English	0.79 (0.64, 0.97)	0.023
Maternal age (<30 years)	0.61 (0.51, 0.71)	<0.001
Maternal age (30-35 years)	*Reference*	
Maternal age (>35 years)	1.27 (1.08, 1.49)	0.003
Single parent family	1.15 (0.85, 1.57)	0.364
2 or more children in household	0.74 (0.64, 0.85)	<0.001
Father's education less than Year 12	0.94 (0.81, 1.09)	0.386
Mother unskilled occupation	1.05 (0.87, 1.28)	0.606
Father unskilled occupation	0.74 (0.56, 0.97)	0.032

Note: OR (95% CI) denotes odds ratio from logistic regression analysis (with 95% confidence interval).

Table 3: Final adjusted model with pregnancy, birth and social factors predicting odds of caesarean section (N=4,862).

	OR (95% CI)	***p***
Maternal smoking in pregnancy	0.87 (0.70, 1.09)	0.238
Use of any medication in pregnancy		
Use of diabetes medication	3.09 (1.74, 5.51)	<0.001
Use of heartburn medication	1.56 (1.13, 2.15)	0.007
Use of over-the-counter medication	1.08 (0.89, 1.32)	0.417
Maternal mental health problems in pregnancy	1.31 (1.10, 1.57)	0.003
Child admitted to intensive care	1.82 (1.51, 2.19)	<0.001
Annual household income	1.05 (1.01, 1.10)	0.011
Language other than English	0.79 (0.64, 0.96)	0.021
Maternal age (<30 years)	0.62 (0.53, 0.73)	<0.001
Maternal age (30-35 years)	*Reference*	
Maternal age (>35 years)	1.25 (1.07, 1.47)	0.007
2 or more children in household	0.74 (0.64, 0.85)	<0.001
Father unskilled occupation	0.74 (0.57, 0.98)	0.036

Note: OR (95% CI) denotes odds ratio from logistic regression analysis (with 95% confidence interval).

amenable to modification. As such, a novel and potentially important finding was the association between maternal mental health problems and CS where the strength of association was at least as strong as the association found between CS and maternal age over 35 years, a well-established risk factor for CS. While mental health problems are common in Australia, affecting approximately one in five adults [32], this was the first Australian study, and one of the first internationally, to examine maternal mental health as a risk factor for CS.

Our study findings build on evidence from the two Swedish population studies described earlier. One study linked data from the Swedish National Inpatient Care Registry 1996–2006 with hospital perinatal records for over 17,000 women, and found that hospital admissions in the five years prior to index birth were associated with an increased risk of elective CS (adjusted OR 2.16, 95% CI 1.34, 4.42), and emergency CS (adjusted OR 1.60, 95% CI 1.09, 2.37), as well as with markers of mental ill-health in pregnancy identified in perinatal records [21]. Another study examined 6,000 nulliparous women and found that report of stress (adjusted OR 1.66, 95% CI 1.34, 2.06), sleep difficulties (adjusted OR 1.57, 95% CI 1.14, 2.16), and worry (adjusted OR 1.41, 95% CI 1.10, 1.79) were all associated with an increased rate of emergency CS in first-time mothers [20].

Speculation on the reason that maternal mental health problems might affect birth outcomes has centred on two possible mechanisms. Firstly, that neuroendocrine-regulated pathways could be affected by maternal anxiety, stress and mood disorders so as to increase the workload of the fetal heart, thus increasing the likelihood of fetal distress [20,33]. Excessive secretion of maternal stress hormones can provoke the release of placental corticotrophin-releasing hormone (CRH), leading to a cascade of events affecting birth outcomes [33]. Alternatively, the presence of maternal mood disorders may be a surrogate for other predisposing factors, such as chronic medical conditions, social disadvantage, or stressful life events [20,33]. In either case, detection in early pregnancy could potentially prompt appropriate evaluation of the pregnant woman and allow remedial management. It would be important to consider these effects using large-scale prospective research methods. For example, prior research has shown a relationship between increased rates of CS and maternal requests for CS [34]. It is possible that this relationship is mediated by women's mental health in pregnancy.

Although we used data from a large prospective study, there are limitations. Data regarding previous caesarean section were unavailable, and it is difficult to identify the proportion of emergency and elective caesarean deliveries. Also, a single item descriptor was used to measure maternal mental health problems as a screening tool but validated screening instruments were not used and it is unclear whether women who reported mental health problems received a formal diagnosis, further investigation, or any treatment. These limitations apply to other similar studies [20,21,33] and these issues would need to be addressed in a properly-constructed prospective study.

Conclusions

In summary, our findings have identified the contribution of maternal mental health problems, and the use of diabetes medication during pregnancy as influential risk factors, adding to the existing pregnancy and social factors known to be associated with CS. There are a small number of other studies suggesting similar links, and our study adds further support by utilizing Australian population-representative data. We believe that further prospective studies should now be undertaken to examine a potential link between maternal mental health problems and pregnancy outcomes, to determine whether screening and early intervention might reduce the overall rate of CS in Australia.

Authors' contributions

The study concept was conceived by SR, EW, and HV. Data extraction and analysis were performed by MY and EW, with additional analytical advice by HV and ALM. The paper was written and finalized by all authors.

Authors' information

SR is a specialist obstetrician. HV is convenor of a University public health program. ALM is a specialist neonatologist. MY is a public health researcher. EW is a public health researcher.

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