



Cesarean Delivery and Healthcare Utilization and Costs in the Offspring: A Retrospective Cohort Study

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Objective To examine the association between cesarean delivery and healthcare utilization and costs in offspring from birth until age 7 years.

Study design A retrospective cohort study of singleton term births in the Canadian province of Nova Scotia between 2003 and 2007 followed until age 7 years was conducted using data from the Nova Scotia Atlee Perinatal Database and administrative health data. The main exposure was mode of delivery (cesarean delivery vs vaginal birth); the outcome was healthcare utilization and costs during the first 7 years of life. Associations were modeled using multiple regression adjusting for maternal prepregnancy weight and sociodemographic factors.

Results In total, 32 464 births were included in the analysis. Compared with children born by vaginal birth, children born by cesarean delivery had more physician visits (incidence rate ratio 1.06, 95% CI 1.05-1.08) and longer hospital stays (incidence rate ratio 1.12, 95% CI 1.03-1.21) and were more likely to be high utilizers of physician visits (OR 1.23, 95% CI 1.10-1.37). Physician and hospital costs were \$775 higher for children born by cesarean delivery compared with vaginal birth.

Conclusions Cesarean delivery compared with vaginal birth is associated with small but statistically significant increases in healthcare utilization and costs during the first 7 years of life. (*J Pediatr* 2019;209:61-7).

The rates of cesarean delivery have been increasing over the past decades with rates as high as 50% in some countries.^{1,2} Approximately one-half of all countries have rates of cesarean delivery above the World Health Organization's estimation of the 15% that are needed as life-saving for the infant.^{3,4} About 10% of births are prelabor elective cesarean delivery,⁵ planned in advance at the mother's request because of cultural, psychosocial, or economic factors.^{6,7} Compared with mothers with a vaginal birth, the odds of severe maternal outcomes such as admission to the intensive care unit, blood transfusion, hysterectomy, or death are almost 6 times higher for women receiving antepartum cesarean delivery without medical indication and over 15 times higher for women receiving an intrapartum cesarean delivery without medical indication.⁵ In addition, the procedure increases a woman's risk for postsurgical bleeding, damage to other organs, surgical site infection, and longer-term outcomes such as complications in future pregnancies.⁸⁻¹⁰

The association between cesarean delivery and childhood health is increasingly being recognized. Following cesarean delivery, the infant's digestive tract is colonized by bacteria that may negatively influence the development of the immune system and energy harvesting in the gut.¹¹ A number of conditions have been reported to be more common in children born via cesarean delivery compared with vaginal birth, including obesity,¹² asthma,^{13,14} food allergies,^{15,16} inflammatory bowel disease,¹⁷ and type I diabetes.¹⁸ Although a number of studies have shown higher healthcare utilization^{19,20} and costs²¹ in the first months after birth with cesarean delivery compared with vaginal birth, no information is available on the association between cesarean delivery and long-term offspring healthcare utilization and costs. We, therefore, examined the association of cesarean delivery with healthcare utilization and costs in a large retrospective cohort of children born in Nova Scotia, Canada from birth until age 7 years.

Methods

This study is a retrospective cohort study of singleton term infants without major congenital anomalies born to mothers residing in the Canadian province of Nova Scotia between 2003 and 2007 who were followed using provincial administrative

ICD	International Classification of Diseases
IRR	Incidence rate ratio
NSAPD	Nova Scotia Atlee Perinatal Database

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health data. At the time of the data abstraction for this project, administrative data was available until 2014; therefore, all children had 7 years of follow-up. Data for the current study came from the Nova Scotia Atlee Perinatal Database (NSAPD) with linkage to administrative health databases for the healthcare utilization and cost data. In Canada, essential health services for all residents are paid for by a single-payer universal healthcare system in each province. Exclusion criteria were missing or implausible (absolute value of birth weight z score >5) birth weight, less than 7 years of follow-up, preterm (<37 weeks) birth, and missing information on mode of delivery or healthcare use. Infants born post-term were included in the study sample.

The study was approved by the IWK Health Center Research Ethics Board (File # 1015756), the Joint Data Access Committee of the Reproductive Care Program of Nova Scotia, and the Health Data Nova Scotia Data Access Committee.

Data Sources

The NSAPD records information on all pregnancies and births to mothers resident in Nova Scotia. Health records personnel obtained and recorded information from standard data collection forms filed in hospital charts for use in the NSAPD. Information includes demographics, diagnoses, morbidity, and mortality data for both mother and infant for each pregnancy as well as routine demographic variables, medical conditions, reproductive history, delivery events, and neonatal outcomes from each delivery record. Data in the NSAPD are regularly checked, edited, abstracted, and validated to ensure quality and validity.²² The administrative health databases used were the Medical Services Insurance Physician Billings database, the Canadian Institute of Health Information Hospital Discharge Abstract Database, and the Insured Patient Registry. The Physician Billings Database was administered by Medavie Blue Cross in Nova Scotia and contains records of each insured health service performed by a physician and paid for by the Nova Scotia provincial health system. Each record contains the date, up to 3 diagnoses in *International Classification of Diseases (ICD), Ninth Revision* format, procedure codes, and the cost of the service. The Hospital Discharge Abstract Database contains information on admissions, separations, and day surgeries, including demographic information, diagnostic codes (ICD-10-CA), procedure codes, and specialty services received. The Insured Patient Registry contains information about each beneficiary of Nova Scotia healthcare services and was used to identify individuals who left the province or died before they were 7 years of age. Because prescription drugs are not universally covered under the Nova Scotia healthcare plan, drug cost information was not available for this study.

The NSAPD was linked to administrative health data using the provincial health card number, a unique identifier that is associated with individuals from birth over their lifetime.

Outcomes

The primary outcome was healthcare utilization during the first 7 years of life, determined as the number of physician visits, number of hospital stays, number of hospital days, physician costs, hospital costs, high utilizer of physician services (>95th percentile for the number of visits, corresponding to ≥ 90 visits), and high utilizer of hospital services (>95th percentile of hospital days, corresponding to ≥ 6 days). The delivery admission was excluded from the analysis. Secondary outcomes were the number of physician visits in each ICD *Ninth Revision* chapter of the primary diagnosis for each visit.

Exposure

The main exposure was mode of delivery (cesarean delivery or vaginal birth). In a secondary analysis, cesarean delivery was grouped into cesarean delivery before the second stage of labor (cervix dilated <10 cm) and cesarean delivery performed during the second stage of labor (cervix dilated to 10 cm).

Confounding Variables

Confounding variables were identified using a directed acyclic graph (Figure 1) and included maternal prepregnancy weight status (not overweight or obese [$< 25 \text{ kg/m}^2$], overweight [$25 \text{ to } < 30 \text{ kg/m}^2$], obese [$\geq 30 \text{ kg/m}^2$]); parity (1, 2, or ≥ 3); maternal age; area of residence (urban or rural, based on the Canadian postal code); area-level income quintile derived from Census of Canada information²³; and birth weight for gestational age and sex categorized based on a Canadian reference population²⁴ as small (<10th percentile for gestational age and sex), large (>90th percentile for gestational age and sex), or appropriate (10th-90th percentile) for gestational age.

Statistical Analyses

Descriptive statistics were summarized by mode of delivery. Generalized linear models were used to investigate the association between mode of delivery and healthcare utilization. The models were adjusted for parity, maternal age, area of residence, area-level income, maternal prepregnancy weight, and birth weight for gestational age category. The association between mode of delivery and the number of physician visits was estimated using negative binomial regression. The relationship between mode of delivery and the number of hospital stays and days, respectively, was examined using a 2-part hurdle model (logistic regression to model having ever stayed in a hospital, and zero-truncated negative binomial regression to model the rates of hospital stays and days, respectively). Results for these models are reported as incidence rate ratios. A generalized linear model with a gamma distribution and a log link function was used to model the association between the mode of delivery and physician costs, and hospital costs were modeled with a 2-part hurdle model (logistic regression followed by gamma model). We were unable to directly determine the hospital costs from our data as Canadian hospitals do not operate on a fee for service basis. We,

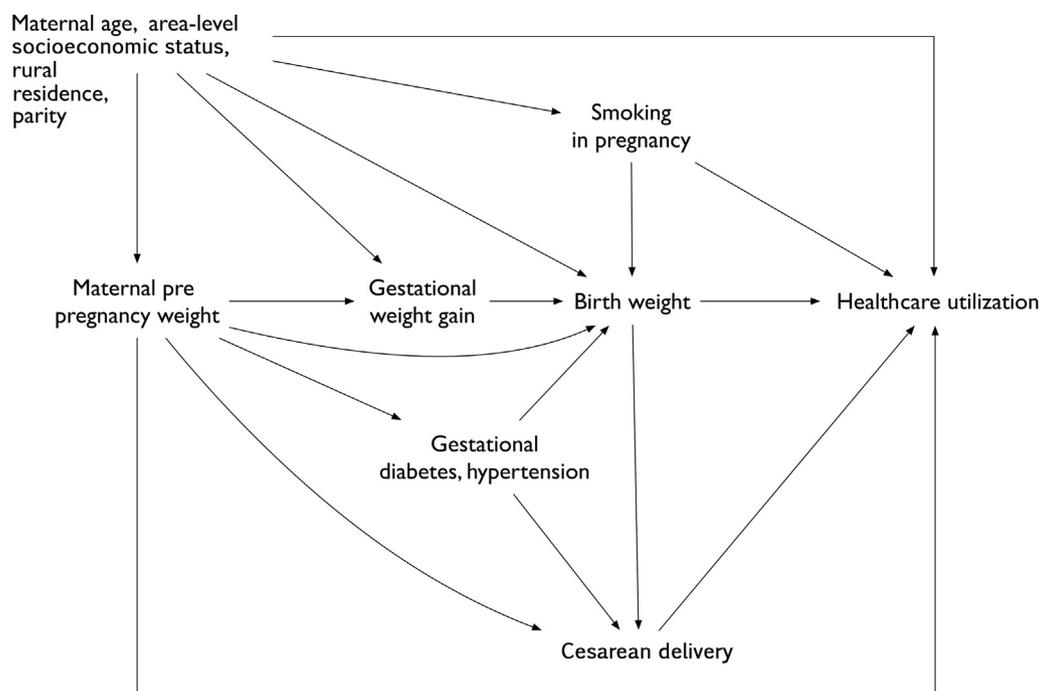


Figure 1. Directed acyclic graph representing the effect of cesarean delivery on offspring healthcare utilization.

therefore, estimated the cost per hospital day as C\$1221 from the average cost of a hospital stay of C\$6107 and average length of stay of 5 days in Nova Scotia in 2014-2015.²⁵ Results from the cost models are presented as multiplicative changes in the expected costs (cost ratios). Logistic regression was used to examine the relationship between mode of delivery and high utilizer status. Multiple imputation ($n = 20$) with chained equations was executed (10 iterations) to impute missing values of the model covariates.²⁶ Physician costs were adjusted to 2014 Canadian Dollars using the Canadian Consumer Price Index for healthcare services.²⁷ The incremental impact of cesarean delivery compared with vaginal birth over the first 7 years of life for the outcomes was estimated from the corresponding regression models. To explore how the association between cesarean delivery and healthcare utilization changes over age, the incidence rate ratios (IRRs) for physician visits and hospital admissions were estimated monthly up to 7 years. Estimates were fit with a smoothed, adjusted generalized additive model and plotted by mode of delivery. Lastly, we calculated the rates of physician visits and hospital admissions over the first seven years of life by mode of delivery for ICD chapter-based disease groups.

Results

A total of 42 050 children were born to mothers resident in Nova Scotia between January 1, 2003 and December 31, 2007, of which 39 369 had nonmissing and plausible birth weight and gestational age information and could be linked with administrative health data. We removed children with less than 7 years of follow-up ($n = 4290$) because of death

or migration out of the province or who were born preterm (<37 weeks, $n = 2609$) or were missing information on mode of delivery or healthcare use ($n = 6$), leaving 32 464 children born to 27 293 mothers in the analysis sample.

Twenty-seven percent of children in the sample were born by cesarean delivery. The sociodemographic and clinical characteristics of the women by mode of delivery are shown in **Table I**. Compared with women who had a vaginal birth, women with cesarean delivery had higher prepregnancy weight and were more likely to have large for gestational age offspring. Women who had a cesarean delivery were also older, more likely to live in an urban area, and less likely to smoke.

Table II presents the results for the association between cesarean delivery and offspring healthcare utilization. Children born by cesarean delivery had significantly more physician visits, hospital admissions, hospital days, and physician costs, and were more likely to be a high utilizer of physician visits and hospital days than children born vaginally. The magnitude of the associations, however, and the corresponding incremental impact was fairly small. The adjusted difference in physician costs during the first 7 years of life between children born by cesarean delivery compared with children born vaginally was C\$159 (95% CI 118, 201) or 9% relative difference; the corresponding estimate for hospital costs was C\$616 (95% CI -341, 1704) or 8% relative difference.

When the exposure was further grouped into cesarean delivery before and during the second stage of labor (**Table III**; available at www.jpeds.com), point estimates of associations relative to vaginal birth were slightly higher with cesarean

Table I. Sociodemographic and clinical characteristics of the cohort by mode of delivery (N = 32 464)

Characteristic	Vaginal birth 72.9% n = 23 653	Cesarean delivery 27.1% n = 8811	P value
Maternal prepregnancy weight status (%)			<.001
Not overweight, not obese	46.4	34.8	
Overweight	18.8	20.4	
Obese	17.4	26.8	
Missing	17.4	18.0	
Maternal age [y] (mean, SD)	28.2 (5.6)	29.9 (5.4)	<.001
Area-level income quintile (%)			.016
Q1 (lowest)	19.7	18.5	
Q2	21.3	21.7	
Q3	22.1	21.3	
Q4	20.9	21.8	
Q5 (highest)	15.6	16.4	
Missing	0.4	0.3	
Area of residence (%)			<.001
Urban	68.7	71.8	
Rural	31.3	28.2	
Parity (%)			<.001
1	43.6	47.7	
2	36.2	37.7	
≥3	20.2	14.6	
Smoking during pregnancy			<.001
Nonsmoker	70.0	74.8	
Smoker	29.3	24.5	
Missing	0.7	0.7	
Offspring sex			<.001
Female	49.9	46.4	
Male	50.1	53.6	
Birth weight for gestational age			<.001
AGA	79.0	71.7	
SGA	6.9	6.8	
LGA	14.1	21.5	

AGA, appropriate for gestational age; LGA, large for gestational age; Q, quintile; SGA, small for gestational age.

delivery before the second stage of labor than during the second stage of labor, but the adjusted differences between the 2 cesarean delivery groups were only significant for the number of hospital days ($P = .033$), respectively.

Figure 2 (available at www.jpeds.com) shows the difference in the rate of physician visits and hospital admissions over age for children born by cesarean delivery compared with children born vaginally; the IRR for physician visits slowly decreased from birth to age 7 years, and the IRR for hospital admissions increased over the same period.

The average number of physician visits for children born by cesarean delivery relative to children vaginally born by ICD chapter are shown in Figure 3. The rate ratios of physician visits for children born by cesarean delivery compared with children born vaginally were highest for diagnoses from the ICD chapters newborn/perinatal (1.48), endocrine and metabolic disorders (1.38), cardiovascular disorders (1.34), and blood disorders (1.32).

Discussion

The present study has expanded on previous work on the relationship between mode of delivery and long-term health by investigating the association between cesarean delivery

Table II. Median and unadjusted and adjusted IRRs, cost ratios, and ORs and adjusted incremental impact for the association between mode of delivery and healthcare utilization in the offspring

Outcome	Vaginal birth	Cesarean delivery
Number of physician visits		
Median (IQR)	39 (27-54)	42 (31-59)
Unadjusted IRR (95% CI)	1.00 (ref)	1.10 (1.08, 1.11)
Adjusted IRR (95% CI)	1.00 (ref)	1.06 (1.05, 1.08)
Adjusted incremental impact	0 (ref)	2.6 (2.0, 3.1)
Number of hospital stays		
Median (IQR)	0 (0-0)	0 (0-1)
Unadjusted IRR (95% CI)	1.00 (ref)	1.12 (1.01, 1.25)
Adjusted IRR (95% CI)	1.00 (ref)	1.14 (1.02, 1.27)
Adjusted incremental impact	0 (ref)	0.0 (0.0, 0.0)
Number of hospital days		
Median (IQR)	0 (0-0)	0 (0-1)
Unadjusted IRR (95% CI)	1.00 (ref)	1.14 (1.05, 1.23)
Adjusted IRR (95% CI)	1.00 (ref)	1.12 (1.03, 1.21)
Adjusted incremental impact	0 (ref)	0.4 (0.1, 0.7)
Physician costs		
Median (IQR)	C\$1458 (939-2238)	C\$1651 (1101-2504)
Unadjusted cost ratio (95% CI)	1.00 (ref)	1.12 (1.10, 1.15)
Adjusted cost ratio (95% CI)	1.00 (ref)	1.09 (1.06, 1.11)
Adjusted incremental impact	0 (ref)	C\$159 (118, 201)
Hospital costs		
Median (IQR)	C\$0 (0-0)	C\$0 (0-1221)
Unadjusted cost ratio (95% CI)	1.00 (ref)	1.10 (0.96, 1.25)
Adjusted cost ratio (95% CI)	1.00 (ref)	1.08 (0.95, 1.23)
Adjusted incremental impact	0 (ref)	C\$616 (-341, 1704)
High utilizer (physician visits)		
%	4.6	6.1
Unadjusted OR (95% CI)	1.00 (ref)	1.34 (1.21, 1.49)
aOR (95% CI)	1.00 (ref)	1.23 (1.10, 1.37)
High utilizer (hospital days)		
%	5.9	6.4
Unadjusted OR (95% CI)	1.00 (ref)	1.08 (0.98, 1.20)
aOR (95% CI)	1.00 (ref)	1.16 (1.05, 1.29)

Models were adjusted for maternal prepregnancy weight status, birth weight for gestational age category, parity, maternal age, area of residence, and area-level income quintile.

and healthcare utilization in childhood. Earlier studies have examined the immediate costs of cesarean delivery birth in the postnatal period and generally found higher costs for mothers following cesarean delivery compared with vaginal birth.^{21,28} Our study compared offspring healthcare costs associated with cesarean delivery and vaginal birth beyond the first months of life. We found a modest increase in the use and costs of health services among children born via cesarean delivery compared with vaginal birth during the first 7 years of life. The higher number of physician visits and hospital stays translate into an estimated excess cost of C\$775 (corresponding to approximately 8% higher healthcare costs) per child born by cesarean delivery during the first 7 years of life. However, the actual cost difference may be larger than this estimate for 2 reasons. First, costs for prescription drugs are not universally covered under the Nova Scotia healthcare plan and were, therefore, not captured. An Australian study on childhood health outcomes following cesarean delivery found an OR of 1.26 (95% CI 1.01, 1.56) for use of prescription medication in 6- to 7-year-old children born by cesarean delivery compared with those born

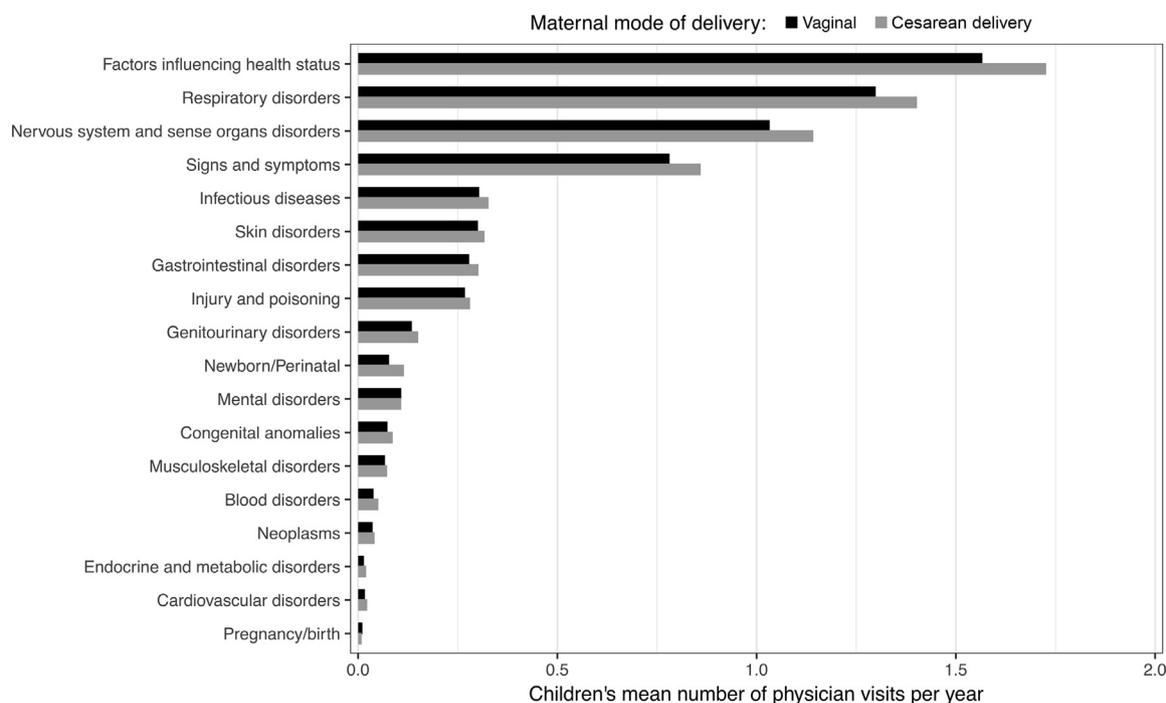


Figure 3. Children's mean number of physician visits per year over the first 7 years of life, by ICD chapter and mode of delivery.

vaginally.²⁹ Second, indirect healthcare costs, such as lost earnings when a parent has to care for a sick child, could also not be considered.

Previous studies found higher risks for chronic conditions such as asthma, obesity, type 1 diabetes, allergic disorders, and celiac disease among children born by cesarean delivery than those born vaginally,^{12,16,18,30} although some of these diseases may be present in the mothers as well and may make them more likely to have a cesarean delivery. Our findings of longer hospital stays and a higher risk of being a high utilizer of physician visits and hospital days also suggest that children born by cesarean delivery may be more likely to suffer from chronic conditions in childhood; high utilizers in our sample accounted for 13% of physician visits and 64% of hospital days in the first 7 years of life. By way of comparison, a recent Canadian study that examined high utilizers found that children (0-17 years of age) who were above the 95th and 99th percentile of healthcare costs incurred 59% and 38% of total expenditures, respectively. The most common diagnoses in these high utilizers were preterm birth, cancer, and mental health disorders.³¹ The difference in the rate of hospital admissions among children born by cesarean delivery compared with those born vaginally increased over the first 7 years of life from about 1.14 to 1.28 (Figure 2). This observation may be explained by the fact that the conditions associated with birth by cesarean delivery only manifest themselves beyond the first years of life. However, the increase should be interpreted with caution given the fairly wide CIs and the fact that the IRR for physician visits showed the opposite trend during the same period. For privacy reasons, we did not have access to individual ICD

codes for each provider contact, and, thus, we were unable to determine which specific conditions contributed to the differences in healthcare use. The ICD chapters from which diagnoses were more frequently coded in children born by cesarean delivery compared with children born vaginally were newborn/perinatal (48% higher), endocrine and metabolic disorders (38% higher), cardiovascular disorders (34%), and blood disorders (32%). In the absence of specific ICD codes, we can only speculate that the first 2 may reflect follow-up care for perinatal complications that had led to cesarean delivery, and childhood obesity¹² or diabetes,¹⁸ respectively.

Alterations in the composition of the microbiota in children born by cesarean delivery are hypothesized to be responsible for the higher risk of immune-related conditions and obesity compared with children born vaginally.¹¹ Our finding of significantly higher healthcare use and costs in the cesarean delivery group are in keeping with this hypothesis, although we also could not exclude the possibility that infants who need to be delivered by cesarean delivery because their mothers do not tolerate labor and also later need more healthcare. When comparing the group of children born by cesarean delivery before the second stage of labor with those born during the second stage of labor, we also found that the former group had increased, albeit nonsignificantly, healthcare utilization. This finding could also be explained with the microbiome hypothesis as children born before the second stage of labor are overall less likely overall to be exposed to the maternal vaginal flora than children born during the second stage of labor. However, a Scottish record linkage study in 321 287 term infants found no difference in adverse

childhood outcomes between children born via planned cesarean delivery compared with unscheduled cesarean delivery, except for a higher risk of type 1 diabetes mellitus (adjusted hazard ratio 1.35).³²

Confounding by maternal prepregnancy maternal weight status constitutes a major threat to the validity of associations between cesarean delivery and childhood health outcomes. Women who are obese are more likely to undergo cesarean delivery³³ and are also more likely to have children who develop obesity and other health problems later in life.³⁴ In the present study, the association between cesarean delivery and healthcare utilization did not change substantially after adjustment for maternal prepregnancy weight status. We cannot exclude residual confounding by indication for cesarean delivery and by maternal morbidity. We did not adjust our models for breastfeeding as part of the effect of cesarean delivery on child health is probably mediated by breastfeeding. A recent study on cesarean delivery and offspring obesity suggested an interaction between mode of delivery and maternal weight status, with the strongest effect seen in offspring of mothers with obesity who underwent cesarean delivery.³⁵ We found no evidence of multiplicative interaction between cesarean delivery and maternal weight status (data not shown). There is also the possibility that women who give birth by cesarean delivery have other characteristics that are associated with the mode of delivery and healthcare use in their offspring that are unrelated to the microbiome; eg, they may be more likely to have chronic health or other conditions including anxiety, which may make them more open to intervention during their birth and potentially also more likely to seek medical care for their offspring. A sibling analysis that compares offspring of the same mother with one born vaginally and the other via cesarean delivery would be able to account for these shared confounders, but may introduce bias due to nonshared confounders such as birth order or indication for cesarean delivery.³⁶

The strengths of the current study are the use of a large population-based cohort in a single payer universal healthcare system and the ability to adjust for a range of confounders. Our findings are limited by attrition because of nonlinkage and loss to follow-up. Nonlinkage because of discrepant or missing health card numbers most likely resulted in missingness at random; comparison of the characteristics of children that were included in the study with those who did not have the full seven years of follow-up showed a lower prevalence of maternal obesity in the excluded observations (14.2% vs 19.9%). We did not have information on antenatal or perinatal administration of antibiotics to the mother, which may have influenced the child's microbiota. Lastly, because of the nature of the Canadian healthcare system, which does not reimburse hospitals on a fee-for-service basis, we had to estimate the cost of a hospital day from the average cost and length of stay, which ignored potential differences in resource use between children born by cesarean delivery and children born vaginally as a result of disease severity and complexity.

Compared with vaginal birth, cesarean delivery is associated with small but statistically significant increases in the use of physician and hospital services during the first 7 years of life for an estimated excess cost of cesarean delivery of \$775. Reduction of cesarean delivery rates may potentially result in lower healthcare utilization and costs in the offspring. More studies are needed to confirm these findings in other populations. ■

Portions of the data used in this report were made available by Health Data Nova Scotia of Dalhousie University. Although this research is based on data obtained from the Nova Scotia Department of Health and Wellness, the observations and opinions expressed are those of the authors and do not represent those of either Health Data Nova Scotia or the Department of Health and Wellness.

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Data Statement

Data sharing statement available at www.jpeds.com.

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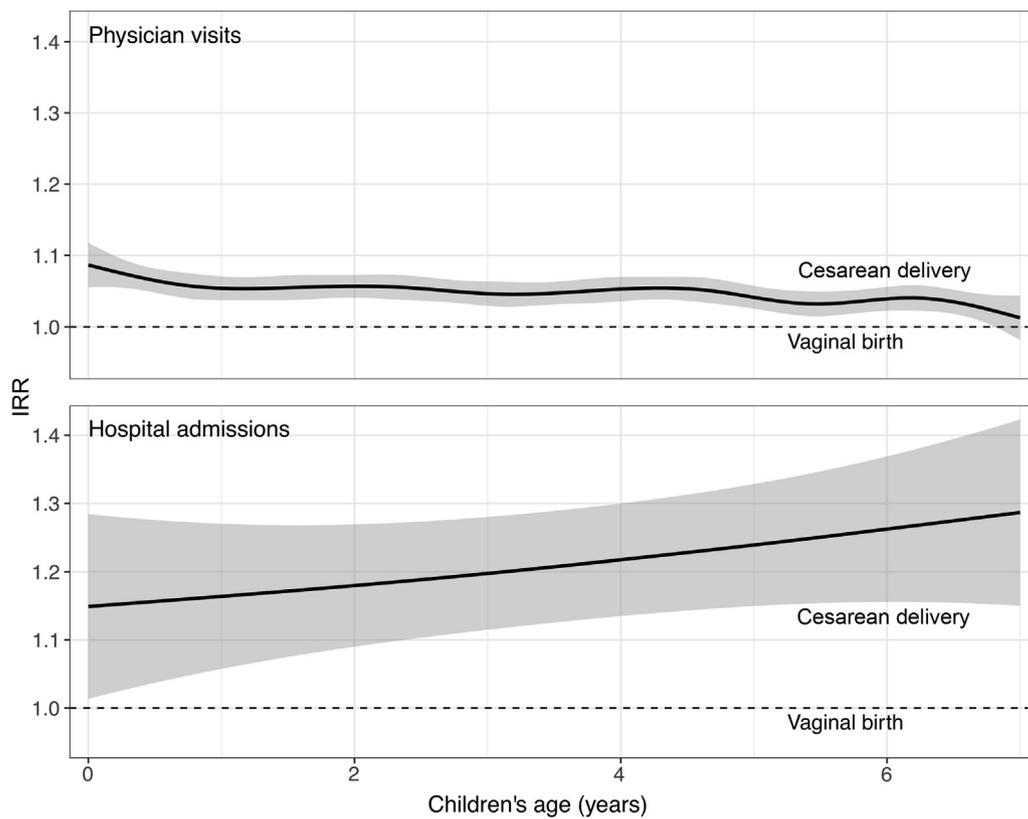


Figure 2. Smoothed IRRs with 95% CIs of offspring physician visits (*top*) and hospital admissions (*bottom*) over the first 18 years of life for cesarean delivery relative to vaginal delivery.

Table III. Unadjusted and adjusted IRRs, cost ratios, and ORs and adjusted incremental impact for the association between cesarean delivery before and during the second stage of labor (relative to vaginal birth) and health care utilization in the offspring

Outcome	Cesarean delivery before second stage of labor	Cesarean delivery during second stage of labor	Vaginal birth	P value*
	n = 6959 (21.4%)	n = 1852 (5.7%)	n = 23 653 (72.9%)	
Number of physician visits				
Unadjusted IRR (95% CI)	1.09 (1.08, 1.11)	1.13 (1.10, 1.15)	1.00 (ref)	.015
Adjusted IRR (95% CI)	1.07 (1.05, 1.08)	1.04 (1.02, 1.07)	1.00 (ref)	.052
Adjusted incremental impact	2.8 (2.2, 3.4)	1.7 (0.6, 2.7)	0 (ref)	-
Number of hospital stays				
Unadjusted IRR (95% CI)	1.13 (1.01, 1.27)	1.08 (0.89, 1.32)	1.00 (ref)	.684
Adjusted IRR (95% CI)	1.16 (1.03, 1.30)	1.06 (0.86, 1.29)	1.00 (ref)	.413
Adjusted incremental impact	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	0 (ref)	-
Number of hospital d				
Unadjusted IRR (95% CI)	1.17 (1.07, 1.27)	1.03 (0.89, 1.19)	1.00 (ref)	.112
Adjusted IRR (95% CI)	1.15 (1.06, 1.26)	0.97 (0.83, 1.13)	1.00 (ref)	.033
Adjusted incremental impact	0.5 (0.2, 0.9)	-0.1 (-0.5, 0.4)	0 (ref)	
Physician costs				
Unadjusted cost ratio (95% CI)	1.12 (1.09, 1.14)	1.15 (1.11, 1.20)	1.00 (ref)	.159
Adjusted cost ratio (95% CI)	1.09 (1.07, 1.12)	1.07 (1.03, 1.12)	1.00 (ref)	.411
Adjusted incremental impact	C\$169 (124, 215)	C\$131 (54, 211)	0 (ref)	-
Hospital costs				
Unadjusted cost ratio (95% CI)	1.12 (0.97, 1.29)	1.02 (0.80, 1.30)	1.00 (ref)	.514
Adjusted cost ratio (95% CI)	1.11 (0.97, 1.28)	0.98 (0.77, 1.24)	1.00 (ref)	.368
Adjusted incremental impact	C\$836 (-239, 2072)	-C\$147 (-1686, 1805)	0 (ref)	-
High utilizer (physician visits)				
Unadjusted OR (95% CI)	1.36 (1.21, 1.53)	1.27 (1.04, 1.56)	1.00 (ref)	.536
aOR (95% CI)	1.29 (1.14, 1.45)	1.04 (0.84, 1.28)	1.00 (ref)	.060
High utilizer (hospital d)				
Unadjusted OR (95% CI)	1.11 (0.99, 1.23)	0.99 (0.81, 1.22)	1.00 (ref)	.329
aOR (95% CI)	1.17 (1.04, 1.31)	1.15 (0.94, 1.41)	1.00 (ref)	.894

Ref, reference.

Models were adjusted for maternal prepregnancy weight status, birth weight for gestational age category, parity, maternal age, area of residence, and area-level income quintile.

*From Wald test for the difference between cesarean delivery before second stage of labor and cesarean delivery during second stage of labor.