

Adolescent Pregnancy Outcomes in the Province of Ontario: A Cohort Study

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Abstract

Objective: Few Canadian studies have examined the association between adolescent pregnancy and adverse pregnancy outcomes. The objective of this cohort study was to characterize the association between adolescent pregnancy and specific adverse maternal, obstetrical, and neonatal outcomes, as well as maternal health behaviours.

Methods: We conducted a retrospective population-based cohort study of all singleton births in Ontario between January 2006 and December 2010, using the Better Outcomes Registry & Network database. Outcomes for pregnant women < 20 years of age (adolescent) were compared with those of women 20 to 35 years old (adult).

Results: This study included 551 079 singleton birth records, 23 992 (4.35%) of which derived from adolescent pregnancies. Adolescents had a higher rate of smoking and substance use than adult women and were within the lowest education and family income quintiles. Adolescents had a significantly lower risk of gestational hypertension (adjusted relative risk [aRR] 0.73) and gestational diabetes (aRR 0.34), placental abruption (aRR 0.80), and placenta previa (aRR 0.36), but their risk of preterm premature rupture of membranes was significantly higher (RR 1.16). Adolescents had a significantly higher proportion of spontaneous vaginal delivery (aRR 1.76), significantly lower rates of use of epidural analgesia (aRR 0.93), of Caesarean section (aRR 0.57), and of assisted vaginal delivery (aRR 0.76), but a

significantly higher risk of emergency CS (aRR 1.31). Neonates with an adolescent mother had significantly higher risks of admission to NICU (aRR 1.08) and very preterm birth (aRR 1.16). There was no significant difference between the two groups in rates of small for gestational age babies, low birth weight, preterm birth, and fetal death. Adolescents had significantly lower rates of prenatal class attendance, prenatal visits in the first trimester, and breastfeeding.

Conclusion: This large Canadian cohort study confirms that, compared with adults, adolescents have improved outcomes such as lower rates of gestational hypertension, gestational diabetes, antepartum hemorrhage, and operative deliveries. However, adolescents also have higher sociodemographic risk factors and seek prenatal care later than adults. These risk factors in combination with young age, lead to other important maternal, obstetrical, and neonatal adverse outcomes. These findings highlight the importance of multidisciplinary prenatal management in the adolescent population to address their high-risk needs, to ensure healthy pregnancies, and to reduce adverse perinatal outcomes.

Résumé

Objectif : Peu d'études canadiennes ont examiné l'association entre la grossesse chez les adolescentes et les issues de grossesse indésirables. Cette étude de cohorte avait pour objectif de caractériser l'association entre la grossesse chez les adolescentes et des issues indésirables maternelles, obstétricales et néonatales particulières, ainsi que les comportements de santé maternels.

Méthodes : Nous avons mené une étude de cohorte rétrospective en population générale portant sur tous les accouchements menés à la suite d'une grossesse monofœtale en Ontario, entre janvier 2006 et décembre 2010, au moyen de la base de données *Better Outcomes Registry & Network*. Les issues des femmes enceintes de moins de 20 ans (adolescentes) ont été comparées à celles des femmes de 20 à 35 ans (adultes).

Key Words: Adolescent pregnancy, adult pregnancy, adverse pregnancy outcomes, sociodemographic, maternal outcomes, obstetrical outcomes, neonatal outcomes, prenatal care, Ontario, Canada

Competing interests: None declared.

Received on August 29, 2012

Accepted on November 28, 2012

Résultats : Cette étude a couvert 551 079 dossiers d'accouchements à la suite d'une grossesse monofœtale, 23 992 (4,35 %) desquels avaient été vécus par des adolescentes. Les adolescentes présentaient un taux plus élevé de tabagisme et de consommation de substances psychotropes que les femmes adultes, et se situaient dans les quintiles inférieurs en matière d'éducation et de revenu familial. Les adolescentes étaient exposées à un risque considérablement moindre d'hypertension gestationnelle (risque relatif corrigé [RRc], 0,73) et de diabète gestationnel (RRc, 0,34), de décollement placentaire (RRc, 0,80) et de placenta prævia (RRc, 0,36); toutefois, leur risque de rupture prématurée des membranes préterme était considérablement accru (RR, 1,16). Les adolescentes ont connu une proportion considérablement accrue d'accouchements vaginaux spontanés (RRc, 1,76) et ont présenté des taux considérablement moindres de recours à l'analgésie péridurale (RRc, 0,93), de césarienne (RRc, 0,57) et d'accouchement vaginal assisté (RRc, 0,76); cependant, elles ont été exposées à un risque considérablement accru de césarienne d'urgence (RRc, 1,31). Les nouveau-nés issus d'une mère adolescente étaient exposés à des risques considérablement accrus d'admission à l'UNSI (RRc, 1,08) et d'accouchement très prématuré (RRc, 1,16). Aucune différence significative n'a été constatée entre les deux groupes en ce qui concerne les taux d'hypotrophie fœtale, de faible poids de naissance, d'accouchement préterme et de décès fœtal. Les adolescentes présentaient des taux considérablement moindres de participation aux classes prénatales, de participation aux consultations prénatales au cours du premier trimestre et d'allaitement.

Conclusion : Cette étude de cohorte canadienne de grande envergure confirme que, par comparaison avec les adultes, les adolescentes connaissent des issues améliorées, telles que des taux moindres d'hypertension gestationnelle, de diabète gestationnel, d'hémorragie antepartum et d'accouchement opératoire. Toutefois, les adolescentes présentent également des facteurs de risque sociodémographiques accrus et cherchent à obtenir des soins prénataux plus tard que les adultes. Ces facteurs de risque, en combinaison avec le jeune âge, mènent à d'autres issues indésirables maternelles, obstétricales et néonatales importantes. Ces résultats soulignent l'importance de la mise en œuvre d'une prise en charge prénatale multidisciplinaire auprès de la population adolescente, et ce, en vue de répondre à leurs besoins liés à leurs risques élevés, de leur assurer une grossesse en santé et d'atténuer les issues périnatales indésirables.

J Obstet Gynaecol Can 2013;35(3):234–245

ABBREVIATIONS

aRR	adjusted relative risk
BORN	Better Outcomes Registry & Network Ontario
LBW	low birth weight
PROM	premature rupture of membranes
PPROM	preterm premature rupture of membranes
PTB	preterm birth
RR	relative risk

INTRODUCTION

The incidence of adolescent pregnancy resulting in a live birth has declined in the past decade, yet it remains a prominent national health concern. Canada's shift in the number of live births within the adolescent population from 19 920 in 1997 to 15 280 in 2007 represents a significant downward trend.¹ This decline is attributable to the inclusion of sex education in schools, increased awareness and use of contraception, and increased availability of abortion services.^{2,3} The increased importance of education and greater focus on aspirations other than motherhood on the part of young women are additional factors associated with the lower pregnancy rates.³ However, even with these societal changes, adolescent pregnancies still account for approximately 4.1% of live births in Canada.¹ Therefore, studies examining the outcomes of these adolescent pregnancies are needed to determine the extent of pregnancy complications in this population. To date, there have been no large cohort Canadian studies assessing adverse pregnancy outcomes in adolescents.

Even though the methodologies may differ significantly, the majority of studies have demonstrated an association between adolescent pregnancy and adverse pregnancy outcomes. Some studies in developed countries have reported an increased risk for preterm delivery,^{4,8} low birth weight,^{4,6,8,9} and small for gestational age infants⁸ in adolescent pregnancies. Others have linked adolescent pregnancy to preeclampsia,⁹ NICU admissions,⁸ and neonatal death.^{5,8,9}

Other important variables that may affect adolescent pregnancies include biological immaturity and sociodemographic risk factors present in the adolescent population.⁶ The suggested role of biological immaturity in increasing the risk of a poor outcome is related to low reproductive age and the competition for nutrients between the still growing adolescent mother and her fetus.¹⁰ Furthermore, several socioeconomic factors are hypothesized to influence the risk of adverse pregnancy outcomes in adolescents. These include maternal health, maternal income, education, and smoking status.¹⁰ It is important to adjust for these confounding variables that may affect adolescent pregnancy outcomes. Indeed, the substantial variation in methodology to adjust for these risk factors may account for the inconsistent findings in studies linking adolescent pregnancy to specific adverse pregnancy outcomes. The objective of this large cohort study was to characterize the association between adolescent pregnancy and specific adverse perinatal, obstetrical, and neonatal outcomes in comparison with those of adult women in Ontario.

Table 1. Definitions

Term	Definition
Assisted delivery	Vaginal delivery assisted with forceps or vacuum of any type
Congenital defects	Any defect or damage to the developing fetus in the uterus
Emergency Caesarean section	Any unplanned Caesarean section in labour
Gestational diabetes	Glucose intolerance with onset or first recognition during pregnancy
Gestational hypertension	Systolic blood pressure ≥ 140 mmHg and/or diastolic blood pressure ≥ 90 mmHg in a previously normotensive pregnant woman who is ≥ 20 weeks of gestation and has no proteinuria
IUGR	Intrauterine growth restriction: fetus below 10th percentile of mean weight for gestation
LGA	Large for gestational age: birth weight of a neonate above the 90th percentile for gestational age
Placental abruption	Abnormal separation of the placenta after 20 weeks of gestation
Placenta previa	Abnormal insertion of the placenta over or near the internal os of the cervix
Preeclampsia	Condition during pregnancy characterized by hypertension and proteinuria
PTL	Preterm labour: delivery before 37 weeks' gestational age
PROM	Premature rupture of the membranes: > 1 hour before the onset of labour
PPROM	Preterm premature rupture of membranes: rupture of membranes prior to onset of labour and fetus < 37 weeks' gestation and > 20 weeks'
SGA	Small for gestational age: birth weight of a neonate below the 10th percentile for gestational age
VPTB	Very preterm birth: delivery before 32 weeks' gestational age

METHODS

We conducted a retrospective population-based cohort study in Ontario using the Better Outcomes Registry & Network Ontario database. The BORN Ontario database collects maternal–newborn information, including socio-demographic, maternal lifestyle, obstetric, intrapartum, and maternal health complications associated with pregnancy for all maternity centres in the province.¹¹ At the time of the audit, 97% of Ontario births were captured in BORN.¹²

In this study population a mother < 20 years of age was considered to have an adolescent pregnancy and a mother between 20 and 35 years old an adult pregnancy. Only women giving birth to a singleton between January 1, 2006, and December 31, 2010, in an Ontario hospital were considered in the analysis. The outcomes were defined by the BORN database and are listed in Table 1.

The demographic characteristics within the Ontario population were stratified by adolescent and adult pregnancies. A log binomial regression model was used to estimate the unadjusted relative risk and 95% confidence intervals for the association of maternal, obstetrical, and neonatal outcomes, comparing adolescent to adult pregnancies. The same model was used to compute the adjusted relative risk and 95% confidence intervals,

adjusting for smoking, parity, median family income, and education. Whenever model convergence issues arose with the log binomial model, a Poisson regression model was used as an alternative.¹³ Records with missing information on maternal age were excluded from all analyses, and those with missing information on specific outcomes were excluded from the analysis of the specific outcome, but were included in the analyses of other outcomes. All data analysis was performed using SAS-EG 9.2 (SAS Institute Inc., Cary, NC).

Ethics approval for the study was provided by the Ottawa Hospital Research Ethics Board.

RESULTS

Our data were drawn from the singleton birth records of a cohort of 551 079 women, 23 992 (4.35%) of which were identified as adolescent pregnancies. Of the records identified as adolescent pregnancies, 23 810 (99.24%) were live births, and of adult pregnancies 523 721 (99.36%) were live births.

Demographic information for all singleton live births to women ≤ 35 years of age in Ontario between January 1, 2006, and December 31, 2010, stratified by adolescent and adult pregnancies, is shown in Tables 2 and 3. The mean

Table 2. Demographic characteristics of adult (20 to 35 years) and adolescent (< 20 years) pregnancies

	Total (n = 547 541)		Adult (n = 523 721)		Adolescent (n = 23 810)	
	n	%	n	%	n	%
Age at time of birth, years, mean (SD)	28.4 (4.5)		28.8 (4.0)		17.9 (1.2)	
Birth weight, grams, mean (SE)	3382.9 (0.738)		3385.4 (0.753)		3327.6 (3.701)	
Gestational age, weeks, mean (SE)	38.9 (0.002)		38.9 (0.002)		38.9 (0.010)	
Smoking in pregnancy*						
No	437 958	86.90	424 566	88.07	13 387	61.17
Yes	66 036	13.10	57 534	11.93	8499	38.83
Missing	43 547	7.95	41 621	7.95	1924	8.08
Substance use*†						
No	476 856	94.62	457 350	94.91	19 497	88.30
Yes	27 095	5.38	24 512	5.09	2583	11.70
Missing	43 590	7.96	41 859	7.99	1730	7.27
Median family income quintiles (neighborhood)*						
1 (lowest)	134 793	25.24	125 168	24.49	9622	42.07
2	107 285	20.09	101 828	19.92	5456	23.86
3	107 123	20.06	103 297	20.21	3822	16.71
4	108 203	20.26	105 472	20.64	2729	11.93
5 (highest)	76 550	14.34	75 308	14.74	1242	5.43
Missing	13 587	2.48	12 648	2.42	939	3.94
Education quintiles (neighborhood)*						
1 (lowest)	111 982	20.97	102 799	20.11	9179	40.13
2	111 374	20.86	105 445	20.63	5927	25.91
3	108 528	20.33	104 578	20.46	3947	17.26
4	108 979	20.41	106 285	20.80	2694	11.78
5 (highest)	93 089	17.43	91 964	17.99	1124	4.91
Missing	13 589	2.48	12 650	2.42	939	3.94
Parity*						
Nulliparous	257 058	47.40	237 005	45.70	20 047	84.82
Primiparous	189 199	34.89	185 992	35.86	3203	13.55
Multiparous	96 047	17.71	95 661	18.44	386	1.63
Missing	5237	0.96	5063	0.97	174	0.73

* $P < 0.001$ for difference between adult and adolescent

†Substance use includes alcohol, cocaine use, gas/glue sniffing, hallucinogens, marijuana, methadone treatment, narcotics, opioids, and any other substances.

maternal age was 17.9 years for the adolescent group (range 11 to 19) and 28.8 years for the adult group ($P < 0.001$). In addition to differences in age, the adolescent group had higher rates of smoking during pregnancy (38.8% vs. 11.9%; $P < 0.001$) and substance use (11.7% vs. 5.1%; $P < 0.001$). The adolescent group was more likely to be in the lowest neighbourhood median family income quintile (42.1% vs. 24.5%, $P < 0.001$), to be in the lowest education neighbourhood quintile (40.1% vs. 20.1%; $P < 0.001$), and to be nulliparous (84.8% vs. 45.7%; $P < 0.001$).

Adverse maternal pregnancy outcomes for all singleton live births are shown in Table 4. When adjusted for smoking, parity, median family income, and education, adolescents had a significantly lower risk than adults of gestational hypertension (aRR 0.73; 95% CI 0.68 to 0.79) and gestational diabetes (aRR 0.34; 95% 0.30 to 0.39). In addition, significant reductions were seen in the risk of PROM (aRR 0.82; 95% CI 0.76 to 0.88), placental abruption (aRR 0.80; 95% CI 0.66 to 0.98), and placenta previa (aRR 0.36; 95% CI 0.28 to 0.55) in adolescent pregnancies.

Table 3. Median neighbourhood family income and education levels in Ontario

Quintile	Median family income, \$	University level degree or diploma, %
1 (lowest)	< 54 053	< 12.0
2	54 053 to 68 215	12.0 to 19.9
3	68 216 to 81 348	20.0 to 28.9
4	81 349 to 97 806	29.0 to 40.9
5 (highest)	≥ 97 807	≥ 41.0

Table 4. Maternal complications of adult (20 to 35 years) and adolescent (< 20 years) pregnancies

Complication	Adult (n = 523 721)	Adolescent (n = 23 810)
Preeclampsia		
n (%)	8034 (1.7)	453 (2.0)
RR (95% CI)	1.00	1.23 (1.12 to 1.34)
aRR (95% CI)*	1.00	0.91 (0.83 to 1.00)
Gestational hypertension		
n (%)	15 890 (3.3)	673 (3.0)
RR (95% CI)	1.00	0.93 (0.86 to 1.00)
aRR (95% CI)*	1.00	0.73 (0.68 to 0.79)
Gestational diabetes		
n (%)	19 785 (4.1)	265 (1.2)
RR (95% CI)	1.00	0.29 (0.26 to 0.33)
aRR (95% CI)*	1.00	0.34 (0.30 to 0.39)
Premature rupture of membranes		
n (%)	15 650 (3.2)	754 (3.4)
RR (95% CI)	1.00	1.05 (0.98 to 1.13)
aRR (95% CI)*	1.00	0.82 (0.76 to 0.88)
Preterm premature rupture of membranes		
n (%)	5634 (1.2)	299 (1.4)
RR (95% CI)	1.00	1.16 (1.03 to 1.29)
aRR (95% CI)*	1.00	0.89 (0.80 to 1.00)
Placental abruption		
n (%)	2468 (0.5)	98 (0.4)
RR (95% CI)	1.00	0.87 (0.72 to 1.06)
aRR (95% CI)*	1.00	0.80 (0.66 to 0.98)
Placenta previa		
n (%)	2609 (0.5)	35 (0.2)
RR (95% CI)	1.00	0.30 (0.22 to 0.42)
aRR (95% CI)*	1.00	0.36 (0.28 to 0.55)

*Adjusted for smoking, parity, median family income, and education.

Table 5. Obstetric outcomes of adult (20 to 35 years) and adolescent (< 20 years) pregnancies

Outcome	Adult (n = 523 721)	Adolescent (n = 23 810)
Vaginal delivery		
n (%)	386 144 (73.8)	19 845 (83.5)
RR (95% CI)	1.00	1.75 (1.69 to 1.81)
aRR (95% CI)*	1.00	1.76 (1.70 to 1.82)
Induction of labour		
n (%)	102 852 (19.7)	5152 (21.7)
RR (95% CI)	1.00	1.12 (1.09 to 1.16)
aRR (95% CI)*	1.00	1.05 (1.02 to 1.08)
Assisted deliveries		
n (%)	63 826 (12.7)	2897 (12.6)
RR (95% CI)	1.00	0.99 (0.95 to 1.03)
aRR (95% CI)*	1.00	0.76 (0.73 to 0.79)
Caesarean section		
n (%)	136 852 (26.2)	3931 (16.5)
RR (95% CI)	1.00	0.57 (0.55 to 0.59)
aRR (95% CI)*	1.00	0.57 (0.55 to 0.59)
Emergency CS†		
n (%)	67 254 (52.9)	2830 (77.9)
RR (95% CI)	1.00	3.06 (2.83 to 3.30)
aRR (95% CI)*	1.00	1.31 (1.20 to 1.43)
Epidural		
n (%)	279 625 (55.0)	13 862 (59.8)
RR (95% CI)	1.00	1.21 (1.18 to 1.24)
aRR (95% CI)*	1.00	0.93 (0.91 to 0.96)

*Adjusted for smoking, parity, median family income, and education.

†Rates calculated using as denominator only women who delivered by Caesarean section (n = 127 079, adult; n = 3631, adolescent).

The risk of PPRM and preeclampsia was higher in adolescents; however, when adjusted for smoking, parity, and neighbourhood median family income and education quintiles, the adjusted risks were lower and did not reach statistical significance (PPROM aRR 0.89; 95% CI 0.80 to 1.00; preeclampsia aRR 0.91; 95% CI 0.83 to 1.00).

Obstetrical outcomes for all singleton live births are summarized in Table 5. Adolescents had a significantly higher proportion of vaginal deliveries than adult women (aRR 1.76; 95% CI 1.70 to 1.82). The adolescent group also had a lower rate of use of epidural analgesia (aRR 0.93; 95% CI 0.91 to 0.96). The risk of operative delivery was significantly lower in adolescents. Indeed, the risk of Caesarean section was 0.57 (95% CI 0.55 to 0.59) and the risk of assisted vaginal delivery was 0.76 (95% CI 0.73 to 0.79) in this group. However, the adolescent group had a significantly higher risk of emergency CS

(aRR 1.31; 95% CI 1.20 to 1.43) than the adult group. The most common indications for emergency CS were dystocia (50.3% adolescents vs. 48.3% adults, $P = 0.030$) and non-reassuring fetal status (36.6% adolescents vs. 33.9% adults, $P = 0.007$) (Table 6).

Adverse neonatal outcomes for all singleton live births are summarized in Table 7. Neonates born to adolescent mothers had significantly higher risks of admission to NICU (aRR 1.08; 95% CI 1.02 to 1.14) and of being born very preterm < 32 weeks (aRR 1.16; 95% CI 1.02 to 1.31) than those born to adult mothers. The risk of having a large for gestational age infant was significantly lower in adolescents (aRR 0.92; 95% CI 0.88 to 0.97). There was no significant difference in risks of SGA (aRR 1.00; 95% CI 0.96 to 1.04), LBW (aRR 1.05; 95% CI 1.00 to 1.11), preterm birth (aRR 1.04; 95% CI 0.99 to 1.09), and fetal death (aRR 1.02; 95% CI 0.88 to 1.18) between the two groups.

Table 6. Indications for emergency Caesarean section in adult (20 to 35 years) and adolescent (< 20 years) pregnancies

Indication	Adult		Adolescent		P†
	n	%*	n	%*	
Breech	6734	10.0	256	9.1	0.054
Cord prolapse	495	0.7	18	0.6	0.189
Diabetes	486	0.7	8	0.3	0.009
Failed forceps/vacuum	1389	2.1	73	2.6	< 0.001
Fetal anomaly	110	0.2	6	0.2	0.193
IUGR/SGA	959	1.4	55	1.9	0.031
LGA	912	1.4	41	1.5	0.209
Maternal request	839	1.3	48	1.7	0.042
Nonprogressive labour/descent/dystocia	32 494	48.3	1424	50.3	0.030
Non-reassuring fetal status	22 820	33.9	1037	36.6	0.007
Placenta previa	722	1.1	12	0.4	0.002
Placental abruption	1336	2.0	40	1.4	0.031
Preeclampsia	1484	2.2	79	2.8	0.045
Prematurity	975	1.5	59	2.1	0.011
Previous Caesarean section	5458	8.1	61	2.2	< 0.001
Premature rupture of membrane	1448	2.2	70	2.5	0.140
Other fetal health problem	3181	4.7	131	4.6	0.204
Other maternal health problem	3337	5.0	153	5.4	0.149
Unknown	808	1.2	25	0.9	0.221

*Percentages were calculated only for those records with complete information on the indication for Caesarean section and do not total 100%.

†P values generated with the exact binomial method.

Maternal health behaviours for all singleton live births are shown in Table 8. The adolescent group had a significantly lower rate of prenatal class attendance (aRR 0.87; 95% CI 0.85 to 0.91), prenatal visits in the first trimester (aRR 0.53; 95% CI 0.51 to 0.55), intention to breastfeed (aRR 0.57; 95% CI 0.54 to 0.59), and breastfeeding exclusively on hospital discharge (aRR 0.73; 95% CI 0.71 to 0.76). Indeed, discontinuation of breastfeeding while in hospital was higher in the adolescent group (aRR 1.17; 95% CI 1.13 to 1.21).

DISCUSSION

Adolescent pregnancy is an important public health challenge in Canada. In Ontario, 4.35% of all live births result from adolescent pregnancy, and these have considerable social and economic repercussions. This large retrospective population-based study in Ontario demonstrates that adolescent females experience maternal, obstetrical, and neonatal complications at a higher rate than adult women. Specifically, adolescents had higher risk factors such as higher rates of smoking and substance use, and they were more likely to be within

the lowest education and family income quintiles than adult women. However, improved outcomes were also seen. For example, adolescents had significantly lower risks of gestational hypertension, gestational diabetes, placental abruption, and placenta previa, although their risk of PPROM was significantly higher than in adults. Additionally, adolescents had a significantly higher proportion of vaginal deliveries, and significantly lower rates of use of epidural analgesia, CS, and assisted vaginal delivery. However, when adolescents required a CS, they had a significantly higher risk of emergency (unplanned) CS because of non-reassuring fetal status or dystocia. Neonates born to adolescent mothers had a significantly higher risk of admission to NICU and of being born very preterm. The risk of having a large for gestational age infant was significantly lower in the adolescent group than in adults. There was no significant difference in rates of SGA, LBW, PTB, and fetal death between the two groups. In addition, the adolescent group had significantly lower rates of prenatal class attendance, prenatal visits in the first trimester, and intention to breastfeed; discontinuation of breastfeeding while in hospital was higher in this group.

Table 7. Neonatal outcomes of live-born singleton adult (20 to 35 years) and adolescent (< 20 years) pregnancies

Outcome	Adult (n = 523 721)	Adolescent (n = 23 810)
Immediate admission to NICU		
n (%)	19 843 (5.1)	1 247 (6.5)
RR (95% CI)	1.00	1.28 (1.21 to 1.35)
aRR (95% CI)*	1.00	1.08 (1.02 to 1.14)
Small for gestational age (10th percentile)		
n (%)	47 306 (9.1)	2 765 (11.7)
RR (95% CI)	1.00	1.31 (1.26 to 1.36)
aRR (95% CI)*	1.00	1.00 (0.96 to 1.04)
Low birth weight (< 2500 grams)		
n (%)	24 113 (4.6)	1501 (6.3)
RR (95% CI)	1.00	1.37 (1.30 to 1.44)
aRR (95% CI)*	1.00	1.05 (1.00 to 1.11)
Large for gestational age (90th percentile)		
n (%)	53 495(10.3)	1899 (8.0)
RR (95% CI)	1.00	0.77 (0.74 to 0.81)
aRR (95% CI)*	1.00	0.92 (0.88 to 0.97)
Preterm birth (< 37 weeks)		
n (%)	31 789 (6.1)	1758 (7.4)
RR (95% CI)	1.00	1.22 (1.17 to 1.28)
aRR (95% CI)*	1.00	1.04 (0.99 to 1.09)
Very preterm birth (< 32 weeks)		
n (%)	3900 (0.8)	273 (1.2)
RR (95% CI)	1.00	1.51 (1.35 to 1.70)
aRR (95% CI)*	1.00	1.16 (1.02 to 1.31)
Fetal/neonatal death†		
n (%)	3366 (0.6)	182 (0.8)
RR (95% CI)	1.00	1.18 (1.02 to 1.36)
aRR (95% CI)*	1.00	1.02 (0.88 to 1.18)

*Adjusted for smoking, parity, median family income, and education.

†Stillbirth (≥ 20 gestational weeks) or neonatal death (< 28 days). We use as denominator all births (live and stillbirths): n = 527 087 for adult; n = 23 992 for adolescent pregnancies.

Many studies have explored the relationship between adverse obstetrical and neonatal outcomes in adolescent pregnancies and sociodemographic risk factors, with varying results.^{5,6,14–16} Some studies have shown that increased rates of smoking, poor nutritional choices, and poverty in the adolescent population predispose them to adverse pregnancy outcomes.^{17,18} Our results demonstrate that although this younger population resides in neighbourhoods with lower education, lower median family income, and higher rates of smoking, the increased risk of adverse birth outcomes remains even after adjustment for these sociodemographic risk factors. Consistent with other studies, this suggests that adverse perinatal outcomes are partly due to young maternal age.^{5,6,19} The variable results

between studies may be due to differing age definitions for adolescents (e.g., 18 years vs. 20 years), differences in health care systems and access to services, and multi-ethnic versus homogenous ethnic population groups.

Adolescent pregnancies in our cohort were associated with lower rates of gestational hypertension after adjusting for potential confounders. However, because race/ethnicity was not captured within the database, we could not adjust for this important variable. Some studies have demonstrated increased rates of preeclampsia and gestational hypertension in adolescents, suggesting that growing adolescents compete with the developing fetus for nutrients, leading to impaired placental perfusion and

Table 8. Maternal behaviours of adult (20 to 35 years) and adolescent (< 20 years) mothers

Behaviour	Adult (n = 523 721)	Adolescent (n = 23 810)
Attended prenatal classes		
n (%)	95 427 (25.5)	5466 (31.2)
RR (95% CI)	1.00	1.31 (1.27 to 1.35)
aRR (95% CI)*	1.00	0.87 (0.85 to 0.91)
Antenatal visit in the first trimester		
n (%)	330 022 (85.5)	13 272 (73.5)
RR (95% CI)	1.00	0.49 (0.48 to 0.51)
aRR (95% CI)*	1.00	0.53 (0.51 to 0.55)
Intention to breastfeed		
n (%)	430 849 (90.1)	17 109 (80.3)
RR (95% CI)	1.00	0.47 (0.46 to 0.49)
aRR (95% CI)*	1.00	0.57 (0.54 to 0.59)
Exclusive breastfeeding on discharge		
n (%)	241 949 (60.6)	8959 (47.4)
RR (95% CI)	1.00	0.60 (0.58 to 0.62)
aRR (95% CI)*	1.00	0.73 (0.71 to 0.76)
Breastfeeding cessation at discharge†		
n (%)	110 888 (33.0)	5769 (41.3)
RR (95% CI)	1.00	1.41 (1.36 to 1.45)
aRR (95% CI)*	1.00	1.17 (1.13 to 1.21)

*Adjusted for smoking, parity, median family income, and education.

†Using as the denominator only records with complete information on intention to breastfeed and breastfeeding on discharge n = 336 104 for adult pregnancies and n = 13 983 for adolescent pregnancies.

subsequent preeclampsia.^{20,21} Others have not shown a difference in rates of gestational hypertension between adolescents and adults of the same parity.²² However, these studies did not control for important variables such as parity, smoking, and substance use. Surprisingly, we found a lower risk of placental abruption in the adolescent group even before adjusting for smoking. This may in part be related to our finding of a lower risk of gestational hypertension in adolescents. To date, no other studies have reported a lower rate of placental abruption in adolescent pregnancy. Adolescents in our cohort had a higher risk of PPRM, consistent with other studies²³; however, this risk was no longer present when potential confounders were adjusted for. Adolescents have a higher incidence of sexually transmitted infection than adults, which increases their risks of PPRM and PTL.^{23–25} Unfortunately, the rate of sexually transmitted infection is not captured in BORN and therefore could not be adjusted for. Adolescents in this cohort had a higher rate of vaginal delivery than adult women, and their rates of assisted vaginal delivery and CS were reduced. Similarly, many studies in developed

countries have demonstrated a higher rate of vaginal delivery in adolescents and a lower rate of CS, with CS rates varying between 2% and 14%.^{5,10} However, when adolescents in our cohort required a CS, it was most often an emergency CS. Fleming et al. found that adolescents receiving specialized multidisciplinary prenatal care adapted for this population had a higher rate of induction of labour for non-reassuring fetal status than adolescents receiving standard obstetrical care, reflecting closer surveillance during pregnancy and better compliance with prenatal visits.²⁶ It is therefore possible that adolescents receiving standard prenatal care may have higher rates of undiagnosed non-reassuring fetal status, leading to higher rates of emergency CS.²⁶ Indeed, the most common reasons for emergency CS in our adolescent group were non-reassuring fetal status and dystocia.

In our cohort, the proportion of adolescents with very preterm birth and admission of neonate to NICU was higher than in the adult group. Previous studies have found similar results, proposing that increased NICU

admission rates are likely a result of increased preterm deliveries.^{10,19,27} Shrim et al. found that Canadian adolescents had a three-fold increase in the risk of delivery before 34 weeks, subsequently leading to increased NICU admissions.¹⁰ This finding is of concern since preterm birth is an important indicator of neonatal well-being and has been associated with severe morbidity and mortality.^{28–31} Two cohort studies demonstrated a significant reduction in the rate of preterm birth when adolescents attended multidisciplinary prenatal care. An Australian cohort showed that screening and treating for sexually transmitted infections resulted in a significantly lower incidence of PTB in the treatment group than in a general prenatal clinic (OR 0.4; 95% CI 0.25 to 0.62).²³ The Canadian study described by Fleming et al. demonstrated that dedicated multidisciplinary care provided in an adolescent-friendly community outreach program led to a 53% reduction in PTB.²⁶ These effective strategies have tremendous potential to reduce the significant health care costs associated with preterm births.

Adolescents in our study were more likely to deliver SGA and LBW infants than adult women. However when adjustments for potential confounders were made, this difference was no longer seen, suggesting that smoking and lower socioeconomic status (income and education) may be risk factors for SGA and LBW. Other reports agree with this finding.^{5,32,33} Briggs et al. found that smoking status was an important risk factor for low birth weight and anemia.³⁴ Adolescents are also known to be at risk of poor maternal weight gain because of suboptimal nutrition, which may increase the risk of low birth weight babies.²⁸ Fleming et al. found that Canadian adolescents followed in a multidisciplinary adolescent-friendly obstetrical outreach program had a 59% reduction in the incidence of LBW babies.²⁶ Indeed, it is important to address nutritional requirements and maternal weight gain when caring for pregnant adolescents; useful strategies may include dietary assessments, comprehensive prenatal nutrition programs, and community food donation programs as well as access to prenatal care.^{26,35,36}

Unfortunately, attendance at prenatal classes and first trimester prenatal care was significantly lower in adolescent women than in adult women, which is consistent with the findings of other studies.^{22,36} Reasons for delay in seeking care are multifactorial and include financial barriers, concerns about judgemental attitudes from health care providers and pregnant adult women, dissatisfaction with clinic waiting times or hours, lack of privacy, and contemplation of abortion.^{22,36} However, when adolescents have the opportunity to attend specialized multidisciplinary

prenatal care adapted for them, they do so.²⁶ Similarly, other studies have reported that consistent prenatal care improves perinatal outcomes in adolescents.^{37–39} Dedicated multidisciplinary prenatal care for adolescents improves screening for psychosocial problems and sexually transmitted infections.²³ Indeed, Fleming et al. found that a multidisciplinary outreach program that brings early and regular prenatal care and education to the adolescent mitigates high-risk maternal behaviours and improves perinatal outcomes.²⁶ We found that adolescents had a lower intention to breastfeed, which was consistent with the findings of other studies.^{40–42} Of the adolescents who initiated breastfeeding, many stopped breastfeeding while in hospital. This may be influenced partly by the higher rate of NICU admission. Attendance at prenatal classes and antenatal and postpartum care that targets this population may improve the breastfeeding intention and continuation rates.

This is the largest study to date documenting pregnancy outcomes in Canadian adolescents, and it confirms the higher risk status of these pregnancies. Through the validated BORN database a large proportion (97%) of singleton hospital births in Ontario between January 1, 2006 and December 31, 2010, were included in the study. This study has shown that adolescent mothers are more likely to smoke, to come from lower income families and/or neighbourhoods, and to reside in areas where the levels of education are among the lowest quintiles in the province. These are all sociodemographic factors that can exaggerate the biological risks associated with pregnancy in young mothers. Our study was able to adjust for these potential confounders, increasing the precision of our models and allowing for greater confidence in our findings. This is important because most of these sociodemographic factors are potentially modifiable risk factors. Multidisciplinary prenatal programs targeting this population may reduce some of these adverse outcomes.

We acknowledge that this study has some limitations. Despite the recording of clinical data by an experienced team, missing data due to coding errors may have reduced the statistical significance of our results. Additional study limitations include the lack of information in the database on other important variables, such as infection screening/treatment, race/ethnicity, and violence, which may have residual confounding effects. The sociodemographic variables maternal median family income and average education were recorded from census information datasets and may therefore not accurately represent those of the mother. Future studies on Canadian adolescent pregnancies that control for these variables are needed.

CONCLUSION

This large Canadian cohort study confirms that, compared with adults, adolescents have improved outcomes such as lower rates of gestational hypertension, gestational diabetes, antepartum hemorrhage, and operative deliveries. However, adolescents also have higher sociodemographic risk factors and seek prenatal care later than adults. These risk factors in combination with young age, lead to other important maternal, obstetrical, and neonatal adverse outcomes. These findings highlight the importance of multidisciplinary prenatal management in the adolescent population to address their high-risk needs, to ensure healthy pregnancies, and to reduce adverse perinatal outcomes.

ACKNOWLEDGEMENTS

This study is based in part on data provided by BORN Ontario, part of the Children's Hospital of Eastern Ontario. The interpretation and conclusions contained herein do not necessarily represent those of BORN Ontario. Dr Mark Walker is a Tier One Research Chair in Perinatal Research at the University of Ottawa.

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