Factors Associated With Increased Rates of Caesarean Section in Women of Advanced Maternal Age

Ghayath Janoudi, MBBS,[1] Sherrie Kelly, MSc,[2,3] Abdool Yasseen, MSc,[1,2,3] Heba Hamam, MBBS,[4] Felipe Moretti, MD,[4] Mark Walker, MD, MSc, MHCM, FRCSC[1,2,3,4]

[1]Ottawa Hospital Research Institute, Ottawa ON

[2]Better Outcomes Registry & Network Ontario, Ottawa ON

[3]Children's Hospital of Eastern Ontario Research Institute, Ottawa ON

[4]Department of Obstetrics and Gynecology, University of Ottawa, Ottawa ON

Abstract

Objective: To compare rates of Caesarean section between mothers of advanced age (35 to 40, and over 40 years) and those aged 20 to 34, using the Robson classification system to examine additional maternal factors.

Methods: A total of 134 088 hospital deliveries in Ontario between April 1, 2011, and March 31, 2012, were grouped into Robson's 10 mutually exclusive and totally inclusive classification categories. Records from the three Robson groups that made the greatest contribution to the overall CS rate were stratified by maternal age, health condition, obstetrical complication, assisted reproductive technology usage, smoking during pregnancy, and socioeconomic status.

Results: Rates of CS increased with advancing maternal age; in women aged 20 to 34, 35 to 40, and over 40, the rates were 26.2%, 35.9%, and 43.1%, respectively. The top three Robson groups by contribution to CS rates involved women who had one or more of the following factors: previous Caesarean section, primiparity, conception by means of assisted reproductive technology, chronic hypertension, gestational diabetes, diabetes mellitus, preeclampsia, placenta previa, placental abruption, or large for gestational age infants. The prevalence of these factors increased with advancing maternal age, yet mothers aged ≥ 35 with one or more health conditions or obstetrical complications had higher CS rates than mothers aged 20 to 34 with the same condition(s) or complication(s).

Conclusion: Health conditions and obstetrical complications alone in older women do not account for increased rates of CS. The preferences of the individual care provider and the mother on CS rates may play a key role and require further investigation.

Key Words: Caesarean section, Robson classification, advanced maternal age, obstetrical factors

Competing Interests: None declared.

Received on October 28, 2014

Accepted on November 26, 2014

Résumé

Objectif : Comparer les taux de césarienne des mères d'âge avancé (de 35 à 40 ans et de plus de 40 ans) à ceux des mères âgées de 20 à 34 ans, en utilisant le système de classification de Robson en vue d'examiner des facteurs maternels additionnels.

Méthodes : Au total, 134 088 accouchements s'étant déroulés en milieu hospitalier en Ontario entre le 1er avril 2011 et le 31 mars 2012 ont été groupés en fonction des 10 catégories mutuellement exclusives et totalement inclusives de Robson. Les dossiers des trois groupes Robson ayant le plus contribué au taux global de césarienne ont été stratifiés en fonction de l'âge maternel, de l'état de santé, des complications obstétricales, du recours à des techniques de procréation assistée, du tabagisme pendant la grossesse et du statut socioéconomique.

Résultats : Les taux de césarienne étaient proportionnels à l'âge maternel : chez les femmes de 20 à 34 ans, de 35 à 40 ans et de plus de 40 ans, les taux ont été de 26,2 %, de 35,9 % et de 43,1 %, respectivement. Les trois groupes Robson ayant le plus contribué au taux global de césarienne étaient composés de femmes qui présentaient un ou plusieurs des facteurs suivants : antécédents de césarienne, primiparité, conception au moyen de techniques de procréation assistée, hypertension chronique, diabète gestationnel, diabète sucré, prééclampsie, *placenta praevia*, décollement placentaire ou hypertrophie fœtale. Bien que la prévalence de ces facteurs ait été proportionnelle à l'âge maternel, les mères âgées de 35 ans ou plus qui comptaient un ou plusieurs troubles de santé (ou complications obstétricales) présentaient des taux de césarienne supérieurs à ceux des mères âgées de 20 à 34 ans qui comptaient le ou les mêmes troubles (ou complications).

Conclusion : Les taux accrus de césarienne chez les femmes plus âgées ne peuvent être attribués qu'à la seule présence de troubles de santé et de complications obstétricales. Les préférences des fournisseurs de soins et des mères en matière d'accouchement pourraient jouer un rôle clé en ce qui concerne les taux de césarienne, ce qui nécessite la tenue d'études plus approfondies.

J Obstet Gynaecol Can 2015;37(6):517–526

INTRODUCTION

Over the last three decades, the number of women 35 years of age and older who were first time mothers in high-income countries has steadily increased.[1] Between 1987 and 2005, Canada witnessed a threefold increase in women 35 and older who gave birth for the first time.[2] Many women in high-income countries delay childbearing until they are 35 or older because they want to complete their education, secure employment, and become financially stable before having children.[3] However, women 35 years of age and older who become pregnant are at increased risk of developing gestational diabetes, having a Caesarean section, having a stillbirth, and giving birth to infants that are preterm, have low birth weight, or have one or more congenital anomaly.[4–8] As a result, mothers of advanced age will undoubtedly require additional health care services and may also have longer hospital stays, thus incurring more associated costs.[9,10]

Understanding the specific childbearing characteristics of women of advanced age compared with their younger counterparts and the underlying causes of the increased CS rates would facilitate targeting of modifiable risk factors in older woman. This would ultimately reduce the need for additional obstetrical intervention, including CS, thus improving outcomes for mothers and infants and reducing the length and cost of these hospital admissions.

The aim of this study was to examine the increased rates of CS in women of advanced maternal age using the Robson classification system,[11] with additional analysis of the impact of maternal health and pregnancy behaviours, maternal medical conditions, obstetrical complications, and socioeconomic status on CS rates.

METHODS

We conducted a retrospective cohort study of women who delivered in a hospital in Ontario, using data from the Better Outcomes Registry & Network, a provincial maternal–child health registry. The cohort was restricted to women ≥ 20 years of age who gave birth to a live born infant of > 20 weeks' gestation and weighing > 500 grams, between April 1, 2011 and March 31, 2012.

ABBREVIATIONS

ART	assisted reproductive technology
BORN	Better Outcomes Registry & Network
IUGR	intrauterine growth restriction
LGA	large for gestational age
PROM	premature rupture of membranes

We examined records for maternal variables including pregnancy history (parity and previous CS), whether assisted reproductive technology methods were used to achieve pregnancy, and maternal smoking status during pregnancy. Each record was then linked by maternal postal code to census data to examine maternal material and social deprivation indices.[12]

Records were then classified into 10 mutually exclusive and totally inclusive Robson groups with sub-group modification following recommendation from the Society of Obstetricians and Gynaecologists of Canada[13] (Table 1). Records within all Robson groups were stratified into three maternal age groups: 20 to 34, 35 to 40, and > 40 years of age. Records falling into the three Robson groups with the greatest contribution to the overall CS rate were examined for pre-existing maternal health conditions (chronic hypertension, pre-existing diabetes, and cardiac disease) and obstetrical complications (gestational hypertension, gestational diabetes, preeclampsia, intrauterine growth restriction [i.e., below the 10th percentile], large for gestation age [i.e., above the 90th percentile], premature rupture of membranes, placenta previa, and placental abruption) for the maternal age groups of 20 to 34 years of age and > 35 years of age (Table 2). Because of small cell sizes that could result in compromised privacy (i.e., risk of identification), the two older age groups were combined for this section of the analysis.

Analysis was conducted using crude and multivariable models adjusting for maternal smoking during pregnancy and material and social deprivation indices. Analyses were conducted using SAS 9.3 software (IBM Corp., Armonk NY).

Ethics approval was obtained from the Ottawa Hospital Research Ethics Board for this study.

RESULTS

There were 38 517 Caesarean sections performed among the 134 088 women who delivered in an Ontario hospital between April 1, 2011, and March 31, 2012, giving an overall CS rate of 28.7% (Table 3). Only 26.2% of younger women aged 20 to 34 delivered by CS (27 180 Caesarean sections in 103 663 women), while 35.9% of women aged 35 to 40 (8818/24 585) delivered by CS (Figure). Moreover, women over 40 years of age had the highest CS rate of any age group (43.1%; 2519/5840). While women from the two older age groups combined (35 to 40 and > 40 years of age) represent only 22.7% of all deliveries, they account for 29.4% of all Caesarean sections.

Consistent with common findings, previous CS was the best predictor of repeat CS.[14–19] The CS rate for mothers with at least one previous CS was 82.1%, compared with only 19.1% for mothers with no previous CS, (RR 4.30, 95% CI 4.24 to 4.36). Moreover, CS rates for mothers with a previous CS increased with advancing maternal age; CS rates were 80.7%, 84.4%, and 87.0% for mothers aged 20 to 34, 35 to 40, and > 40, respectively. While the proportion of primiparous women decreased with increasing maternal age (from 45.5% in women aged 20 to 34 to 27.7% in women over 40 years of age), CS rates for primiparas increased with advancing maternal age, from 27.0% at age 20 to 34 to 40.4% at age 35 to 40, and to 52.0% in women > 40 years of age. In the overall obstetric population (vaginal and CS deliveries combined) CS rates were 26.2% in women aged 20 to 34, 35.0% in women aged 35 to 40, and 43.1% in women > 40 years of age. Women whose records indicated that assisted reproductive technology was used to conceive showed statistically significant higher rates of CS than those in whom ART was not used (RR 1.66, 95% CI 1.60 to 1.73). These rates also increased with advancing maternal age, from 39.5% in women aged 20 to 34 to 64.2% in women aged > 40 (with the use of ART), while the rates in the same age groups increased from 25.6% to 40.6% (when ART was not used). Conversely, smoking during pregnancy did not show a statistically significant increase in risk of CS for any age group. Records from the three maternal age groups showed an almost equal distribution across all quintiles of material and social deprivation indices; CS rates increased with advancing maternal age in a manner similar to increases in the total obstetrical population of the same age (Table 2). There were 8721 records with missing data for one or more variable (6.5%), and these were excluded from the analysis.

Consistent with previous findings,[14,15,17–19] the largest relative contributor to the CS rate was the group of women with at least one previous CS and a term, singleton, cephalic-presenting pregnancy (Robson group 5), which was the same for all age groups (Table 4). The next largest contributing group was nulliparous women with a term, singleton, cephalic-presenting pregnancy who had labour induced or who delivered by CS before labour (Robson group 2), which also was the same across all age groups. Women in Robson group 1 (nulliparous women with a term, singleton, cephalic-presenting pregnancy with spontaneous labour) accounted for the third-largest contribution in women aged 20 to 34 and 35 to 40, while for women over 40 the third-largest contributors were women in Robson group 7 (multiparous women with singleton, breech-presenting pregnancies). Across all age groups, women with the highest CS rates were, not surprisingly, those classified in Robson group 6 (nulliparous women with singleton, breech-presenting pregnancies).

Table 1. Modified Robson classification system

Group	Description
1	Nulliparous, singleton, cephalic, ≥ 37 weeks, spontaneous labour
2	Nulliparous, singleton, cephalic, ≥ 37 weeks, induced labour or CS before labour (a) Induced (b) Caesarean
3	Multiparous women, singleton, cephalic, ≥ 37 weeks, without a previous CS, spontaneous labour
4	Multiparous, singleton, cephalic, ≥ 37 weeks, without a previous uterine scar, induced labour or by CS before labour (a) Induced (b) Caesarean
5	Multiparous, singleton, cephalic, ≥ 37 weeks, with a previous CS (a) Spontaneous (b) Induced (c) Caesarean
6	Nulliparous, singleton, breech (a) Spontaneous (b) Induced (c) Caesarean
7	Multiparous, singleton, breech (a) Spontaneous (b) Induced (c) Caesarean
8	Multiple pregnancy (twins or higher-order multiples) (a) Spontaneous (b) Induced (c) Caesarean
9	Singleton, transverse, or oblique lie (a) Spontaneous (b) Induced (c) Caesarean
10	Singleton, cephalic, < 37 weeks (a) Spontaneous (b) Induced (c) Caesarean

Data on maternal age, health condition, and obstetrical complication were extracted from the records of the three Robson groups contributing most to the CS rate (groups 1, 2, and 5). The data for older women aged 35 to 40 and > 40 years had to be combined to reduce the risk of patient re-identification because of small cell sizes (< 6), resulting in two age groups (20 to 34 years and 35 years and older) (Tables 5, 6, and 7). For Robson groups 1, 2, and 5, women with chronic hypertension, gestational diabetes, diabetes mellitus (in Robson groups 5 and 2), or preeclampsia had higher CS rates (Tables 5, 6, and 7). Women in Robson

Table 2. Rate of Caesarean section by maternal factor in Ontario, 2011 to 2012

	Maternal age					
	20 to 34 years (n = 103 663)			35 to 40 years (n = 24 585)		
	Prevelance, %	Caesarean sections, n (%)	Relative risk RR (95% CI)	Prevelance, %	Caesarean sections, n (%)	Relative risk RR (95% CI)
Maternal health problems						
Chronic hypertension	0.6	285 (47.3)	1.84 (1.69–2.00)	1.2	166 (55.7)	1.59 (1.44–1.76)
Diabetes mellitus type 1 and 2	1.5	639 (42.4)	1.65 (1.55–1.75)	2.7	321 (48.1)	1.37 (1.27–1.49)
Cardiac disease	0.4	158 (34.1)	1.33 (1.17–1.51)	0.5	49 (37.4)	1.07 (0.86–1.33)
Missing data, n		4925			963	
Obstetrical complications						
Gestational diabetes	3.9	1348 (33.4)	1.39 (1.33–1.45)	7.8	808 (42.0)	1.27 (1.20–1.35)
Gestational hypertension	3.2	1152 (34.9)	1.45 (1.38–1.52)	3.6	372 (42.3)	1.28 (1.18–1.39)
Preeclampsia	1.8	789 (42.1)	1.75 (1.66–1.85)	2.2	286 (53.3)	1.62 (1.49–1.75)
IUGR (10th percentile)	2.4	794 (32.0)	1.33 (1.25–1.41)	2.1	211 (40.0)	1.22 (1.09–1.35)
LGA (90th percentile)	1.5	743 (46.3)	1.92 (1.82–2.03)	1.7	217 (51.1)	1.55 (1.41–1.70)
Premature rupture of membrane	3.4	774 (22.2)	0.92 (0.87–0.98)	3.1	241 (31.4)	0.95 (0.86–1.06)
Placenta previa	0.5	458 (88.9)	3.70 (3.58–3.82)	1.0	226 (93.0)	2.82 (2.71–2.94)
Placental abruption	0.5	324 (59.2)	2.46 (2.29–2.64)	0.6	97 (61.0)	1.85 (1.63–2.10)
Missing data, n		3836			785	
	> 40 years (n = 5840)			All age groups (N = 134 088)		
	Prevelance, %	Caesarean sections, n (%)	Relative risk RR (95% CI)	Prevelance, %	Caesarean sections, n (%)	Relative risk RR (95% CI)
Maternal health problems						
Chronic hypertension	2.4	85 (59.9)	1.42 (1.23–1.63)	0.8	536 (51.4)	1.83 (1.72–1.94)
Diabetes mellitus type 1 and 2	3.9	116 (50.4)	1.19 (1.05–1.36)	1.8	1076 (44.7)	1.59 (1.52–1.66)
Cardiac disease	0.5	18 (58.1)	1.37 (1.02–1.86)	0.5	225 (36)	1.28 (1.15–1.42)
Missing data, n		207			6095	
Obstetrical complications						
Gestational diabetes	10.2	286 (47.8)	1.23 (1.12–1.34)	4.9	2442 (37.2)	1.42 (1.38–1.47)
Gestational hypertension	4.8	142 (50.4)	1.29 (1.14–1.46)	3.3	1666 (37.3)	1.42 (1.37–1.48)
Preeclampsia	2.9	120 (69.8)	1.79 (1.61–1.99)	1.9	1195 (46.3)	1.77 (1.69–1.84)
IUGR (10th percentile)	2.3	68 (50.4)	1.29 (1.09–1.53)	2.3	1073 (34.1)	1.30 (1.24–1.37)
LGA (90th percentile)	1.7	54 (55.7)	1.43 (1.19–1.71)	1.6	1014 (47.7)	1.82 (1.74–1.90)
Premature rupture of membrane	3.2	71 (38.4)	0.98 (0.82–1.19)	3.3	1086 (24.5)	0.93 (0.89–0.98)
Placenta previa	1.3	75 (96.2)	2.47 (2.32–2.61)	0.6	759 (90.8)	3.47 (3.38–3.55)
Placental abruption	0.8	34 (73.9)	1.89 (1.59–2.26)	0.6	455 (60.5)	2.31 (2.18–2.45)
Missing data, n		176			4797	

IUGR: intrauterine growth restriction; LGA: large for gestational age

groups 1 and 2 with LGA infants had CS rates of 74.1% and 80.6%, respectively, in women aged 35 and older, while women aged 20 to 34 had a CS rate of 44.1% and 64.0%, for Robson groups 1 and 2, respectively.

In Robson group 2, placenta previa was associated with a statistically significant increased risk of CS in both age groups. In women from Robson group 5 with the indication of placenta previa, the CS rate in younger women 20 to 34 was 93.0%, while for women 35 and older it was 90.7%. Data were not available for records classified in Robson group 1 for this obstetrical complication. Lastly, women who experienced placental abruption had higher CS rates compared with women with no obstetrical complications or compared with the overall obstetrical population (other than for women aged 35 and older from Robson group 5).

Of note, women who experienced premature rupture of membranes or IUGR (less than the 10th percentile) had lower CS rates than women with no obstetrical complications for any age or Robson group, except for (a) women aged 20 to 34 in Robson group 1 with PROM (RR 1.27, 95% CI 1.10 to 1.46), and (b) women aged 35 and older from Robson group 1 with IUGR (RR 1.31, 95% CI 0.76 to 2.28).

Table 3. Rate of Caesarean section by maternal factor for Ontario, 2011–2012

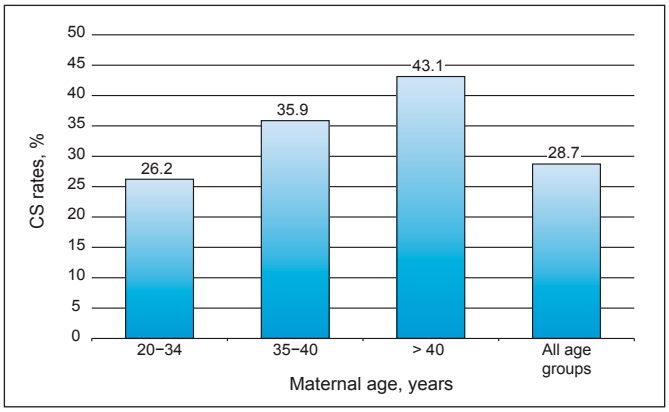
	Maternal age					
	20 and 34 years (n = 103 663)			35 and 40 years (n = 24 585)		
Maternal factors	Prevelance in this age group, %	Caesarean sections (n = 27 180) n (%)	Relative risk RR (95% CI)	Prevelance in this age group, %	Caesarean sections (n = 8818) n (%)	Relative risk RR (95% CI)
Parity						
Primiparous	45.5	12 725 (27.0)	1.06 (1.04–1.08)	27.3	2 710 (40.4)	1.19 (1.04–1.12)
Multiparous	53.5	14 076 (25.4)	0.94 (0.92–0.96)	71.7	5 993 (34.0)	0.84 (0.81–0.87)
Missing data, n		1062			254	
Previous Caesarean section						
Yes	12.9	10 771 (80.7)	4.45 (4.38–4.53)	22.6	4 696 (84.4)	3.92 (3.80–4.03)
No	85.2	15 996 (18.1)	0.23 (0.22–0.23)	75.9	4 019 (21.5)	0.26 (0.25–0.26)
Missing data, n		1994			366	
Assisted reproductive technology						
Yes	1.7	686 (39.5)	1.54 (1.45–1.64)	4.4	527 (49.1)	1.40 (1.31–1.49)
No	82.1	21 821 (25.6)	0.65 (0.61–0.69)	78.2	6 765 (35.2)	0.72 (0.67–0.76)
Missing data, n		16 817			4278	
Smoking status during pregnancy						
Yes	10.7	2 851 (25.8)	0.99 (0.96–1.02)	5.0	446 (36.5)	1.03 (0.96–1.11)
No	83.6	22 598 (26.1)	1.01 (0.98–1.05)	89.2	7 763 (35.4)	0.97 (0.90–1.05)
Missing data, n		5926			1444	
Material deprivation index						
Qunitile 1 (lowest)	15.1	3 997 (25.5)	0.97 (0.94–1.00)	22.8	1 882 (33.5)	0.92 (0.88–0.96)
Qunitile 2	19.3	5 203 (26.0)	0.99 (0.97–1.02)	21.4	1 875 (35.6)	0.99 (0.95–1.03)
Qunitile 3	18.8	5 161 (26.4)	1.01 (0.99–1.04)	17.2	1 570 (37.1)	1.04 (1.00–1.09)
Qunitile 4	19.3	5 199 (25.9)	0.99 (0.97–1.02)	16.6	1 465 (35.9)	1.00 (0.96–1.05)
Qunitile 5 (highest)	22.4	6 202 (26.7)	1.03 (1.00–1.05)	17.6	1 639 (37.9)	1.07 (1.03–1.11)
Missing data, n		5090			1065	
Social deprivation index						
Qunitile 1 (lowest)	18.4	4 861 (25.5)	0.97 (0.95–1.00)	20.6	1 796 (35.5)	0.99 (0.95–1.03)
Qunitile 2	18.6	5 062 (26.2)	1.01 (0.98–1.03)	19.8	1 722 (35.3)	0.98 (0.94–1.02)
Qunitile 3	19.0	5 149 (26.1)	1.00 (0.97–1.03)	19.2	1 689 (35.8)	1.00 (0.96–1.04)
Qunitile 4	19.3	5 293 (26.5)	1.02 (0.99–1.04)	19.1	1 715 (36.5)	1.02 (0.98–1.07)
Qunitile 5 (highest)	19.8	5 397 (26.3)	1.01 (0.98–1.03)	17.0	1 509 (36.2)	1.01 (0.97–1.06)
Missing data, n		5090			1065	
	> 40 years (n = 5840)			All age groups (N = 134 088)		
	Prevelance in this age group, %	Caesarean sections (n = 2519) n (%)	Relative risk RR (95% CI)	Prevelance	Caesarean sections (n = 38 517) n (%)	Relative risk RR (95% CI)
Parity						
Primiparous	27.7	840 (52)	1.32 (1.24–1.40)	41.4	16 275 (29.3)	1.04 (1.03–1.06)
Multiparous	71.1	1638 (39.5)	0.76 (0.71–0.81)	57.6	21 707 (28.1)	0.96 (0.94–0.98)
Missing data, n		73			1389	
Previous Caesarean section						
Yes	24.2	1229 (87)	2.99 (2.84–3.15)	15.2	16 696 (82.1)	4.30 (4.24–4.36)
No	74.6	1267 (29.1)	0.33 (0.32–0.35)	83.0	21 282 (19.1)	0.23 (0.23–0.24)
Missing data, n		74			2434	
Assisted reproductive technology						
Yes	8.8	328 (64.2)	1.58 (1.47–1.70)	2.5	1541 (46.4)	1.66 (1.60–1.73)
No	73.4	1740 (40.6)	0.63 (0.59–0.68)	81.0	30 326 (27.9)	0.60 (0.58–0.63)
Missing data, n		1041			22 136	

Continued

Table 3. Continued

	> 40 years (n = 5840)			All age groups (N = 134 088)		
	Prevelance in this age group, %	Caesarean sections (n = 2 519) n (%)	Relative risk RR (95% CI)	Prevelance	Caesarean sections (n = 38 517) n (%)	Relative risk RR (95% CI)
Smoking status during pregnancy						
Yes	5.2	122 (40.3)	0.94 (0.81–1.08)	9.4	3419 (27.2)	0.95 (0.92–0.98)
No	88.9	2 230 (43)	1.07 (0.93–1.23)	84.9	32 591 (28.6)	1.05 (1.02–1.09)
Missing data, n		348			7718	
Material deprivation index						
Qunitile 1 (lowest)	24.1	620 (44)	1.03 (0.96–1.10)	16.9	6499 (28.6)	1.00 (0.98–1.02)
Qunitile 2	20.7	521 (43.2)	1.00 (0.93–1.08)	19.8	7599 (28.7)	1.00 (0.98–1.02)
Qunitile 3	16.5	406 (42.2)	0.98 (0.90–1.06)	18.4	7137 (28.9)	1.01 (0.99–1.03)
Qunitile 4	16.1	410 (43.5)	1.01 (0.93–1.10)	18.7	7074 (28.2)	0.98 (0.96–1.00)
Qunitile 5 (highest)	18.3	451 (42.2)	0.98 (0.90–1.05)	21.4	8292 (28.9)	1.01 (0.99–1.03)
Missing data, n		252			6407	
Social deprivation index						
Qunitile 1 (lowest)	20.7	482 (40)	0.91 (0.84–0.98)	18.9	7139 (28.2)	0.98 (0.96–1.00)
Qunitile 2	19.0	470 (42.4)	0.98 (0.91–1.06)	18.9	7254 (28.7)	1.00 (0.98–1.02)
Qunitile 3	18.9	494 (44.7)	1.05 (0.97–1.13)	19.0	7332 (28.7)	1.00 (0.98–1.02)
Qunitile 4	18.9	505 (45.7)	1.08 (1.00–1.16)	19.2	7513 (29.1)	1.02 (1.00–1.04)
Qunitile 5 (highest)	18.2	457 (42.9)	1.00 (0.92–1.07)	19.2	7363 (28.6)	1.00 (0.97–1.02)
Missing data, n		252			6407	

Caesarean section by maternal age group in Ontario, 2011 to 2012



DISCUSSION

Our analysis of 134 088 women who gave birth in an Ontario hospital in 2011–2012 showed that CS rates were higher among mothers of advanced age, increasing from 26.2% for younger mothers aged 20 to 34 to 35.9% in women aged 35 to 40 and to 43.1% for those aged over 40. Maternal factors associated with increased CS rates included previous CS, primiparity, and use of ART. Maternal smoking during pregnancy and socioeconomic deprivation indices showed no effect on the rate of CS.

Women in Robson groups 2 and 5 were the largest contributors to the overall CS rate for all three age groups. Robson group 1 was the third-largest contributor to the overall CS rate for women aged 20 to 34 and 35 to 40, whereas Robson group 7 was the third largest contributor for women aged over 40. Records from the three Robson groups contributing most to the overall CS rate (Robson groups 1, 2, or 5) showed that women aged 35 or older experienced a greater number of health conditions and/or obstetrical complications than women aged 20 to 34. However, women aged 35 or older still had higher CS rates than women aged 20 to 34 with the same health condition(s) and/or obstetrical complication(s), suggesting that other factors may contribute to higher CS rates in older women.

Maternal health conditions and obstetrical complications that were associated with increased CS rates included chronic hypertension, gestational diabetes, diabetes mellitus (Robson groups 1 and 2), preeclampsia, LGA (Robson groups 1 and 2), placenta previa (Robson group 2), and placental abruption (Robson group 1). Women who experienced PROM or IUGR (below the 10th percentile), had predominantly lower CS rates than women with no obstetrical complication for any age or Robson group.

The Robson system is a straightforward surveillance tool that has been implemented at the institutional,

Table 4. Relative size and contribution to overall CS rate by Modified Robson classification groups and maternal age for Ontario, 2011–2012

	20 to 34 years			35 to 40 years			> 40 years			All		
Robson group	Number of deliveries, n	Relative size of each group,* %	Contribution of each group to overall CS rate,† %	Number of deliveries, n	Relative size in each group,* %	Contribution of each group to overall CS rate,† %	Number of deliveries, n	Relative size in each group,* %	Contribution of each group to overall CS rate,† %	Number of deliveries, n	Relative size in each group,* %	Contribution of each group to overall CS rate,† %
1	25 885	25.0	3.7	3082	12.5	2.8	591	10.1	2.9	29 558	22.0	3.5
2	13 239	12.8	4.5	2094	8.5	4.2	595	10.2	6.3	15 928	11.9	4.5
a	12 162	11.7	3.5	1765	7.2	2.9	443	7.6	3.7	14 370	10.7	3.4
b	1077	1.0	1.0	329	1.3	1.3	152	2.6	2.6	1558	1.2	1.2
3	26 660	25.7	0.6	7334	29.8	1.2	1 474	25.2	1.2	35 468	26.5	0.8
4	9771	9.4	1.0	2995	12.2	1.5	813	13.9	2.5	13 579	10.1	1.1
a	9266	8.9	0.5	2806	11.4	0.8	477	8.2	1.3	12 816	9.6	0.6
b	505	0.5	0.5	188	0.8	0.8	69	1.2	1.2	762	0.6	0.6
5	10 219	9.9	8.0	4201	17.1	14.5	1022	17.5	15.0	15 442	11.5	9.5
a	2900	2.8	1.3	1082	4.4	2.2	259	4.4	2.4	4241	3.2	1.5
b	444	0.4	0.1	135	0.5	0.2	35	0.6	0.1	614	0.5	0.1
c	6872	6.6	6.6	2981	12.1	12.1	728	12.5	12.5	10 581	7.9	7.9
6	2183	2.1	2.0	426	1.7	1.7	116	2.0	1.9	2725	2.0	1.9
a	660	0.6	0.6	103	0.4	0.4	23	0.4	0.4	786	0.6	0.5
b	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
c	1429	1.4	1.4	304	1.2	1.2	85	1.5	1.5	1818	1.4	1.4
7	1481	1.4	1.3	590	2.4	2.2	211	3.6	3.3	2282	1.7	1.6
a	507	0.5	0.4	181	0.7	0.6	51	0.9	0.7	739	0.6	0.4
b	81	0.1	0.0	23	0.1	0.1	15	0.3	0.1	119	0.1	0.1
c	886	0.9	0.9	384	1.6	1.6	145	2.5	2.5	1415	1.1	1.1
8	1713	1.7	1.0	615	2.5	1.6	182	3.1	2.3	2510	1.9	1.2
a	711	0.7	0.3	222	0.9	0.5	58	1.0	0.7	991	0.7	0.4
b	383	0.4	0.1	135	0.5	0.1	44	0.8	0.3	562	0.4	0.1
c	602	0.6	0.6	252	1.0	1.0	79	1.4	1.4	933	0.7	0.7
9	813	0.8	0.6	261	1.1	0.9	80	1.4	1.3	1154	0.9	0.7
a	332	0.3	0.2	84	0.3	0.2	19	0.3	0.3	435	0.3	0.2
b	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
c	358	0.3	0.3	144	0.6	0.6	57	1.0	1.0	559	0.4	0.4
10	5021	4.8	1.2	1330	5.4	2.0	370	6.3	2.8	6721	5.0	1.4
a	3298	3.2	0.4	807	3.3	0.7	209	3.6	1.0	4314	3.2	0.5
b	1069	1.0	0.2	274	1.1	0.3	72	1.2	0.3	1415	1.1	0.2
c	653	0.6	0.6	248	1.0	1.0	89	1.5	1.5	990	0.7	0.7
Missing data, n		6678			1657			386			8721	
Total obstetrical population	103 663	100.0	26.2	24 585	100.0	35.9	5 840	100.0	43.1	134 088	100.0	28.7

ND: Not done because cell size < 6

*Relative size of each group was calculated as the number of deliveries (n) divided by the total obstetric population, multiplied by 100.

†Contribution of each group to the overall CS rate was calculated as the number of CSs (data not shown), divided by the total obstetric population, multiplied by 100.

Table 5. Caesarean rate in Robson group 5 by maternal age, maternal health condition, and obstetric complication, Ontario, 2011–2012*

	Maternal age								
	20 to 34 years (n = 10 219)			≥ 35 years (n = 5223)			All age groups (n = 15 442)		
	Prevelance, %	Caesarean sections, n (%)	Relative risk RR (95% CI)	Prevelance, %	Caesarean sections, n (%)	Relative risk RR (95% CI)	Prevelance, %	Caesarean sections, n (%)	Relative risk RR (95% CI)
Maternal health conditions									
Chronic hypertension	0.8	75 (92.6)	1.14 (1.07–1.22)	1.4	72 (96.0)	1.14 (1.08–1.19)	1.0	147 (94.2)	1.15 (1.10–1.19)
Diabetes mellitus type 1 and 2	2.0	193 (93.7)	1.16 (1.11–1.20)	3.1	151 (92.1)	1.09 (1.04–1.14)	2.4	344 (93.0)	1.13 (1.10–1.16)
Cardiac disease	0.5	44 (81.5)	1.01 (0.89–1.14)	0.5	21 (87.5)	1.04 (0.89–1.21)	0.5	65 (83.3)	1.01 (0.92–1.12)
Missing data, n		272			123			95	
Obstetrical complications									
Gestational diabetes	4.9	439 (87.5)	1.06 (1.03–1.10)	9.0	426 (90.6)	1.06 (1.03–1.10)	6.3	865 (89.0)	1.07 (1.04–1.09)
Gestational hypertension	2.4	202 (83.8)	1.02 (0.96–1.08)	2.8	127 (88.2)	1.03 (0.97–1.10)	2.5	329 (85.5)	1.03 (0.98–1.07)
Preeclampsia	0.7	56 (80.0)	0.97 (0.86–1.09)	1.0	50 (94.3)	1.11 (1.03–1.18)	0.8	106 (86.2)	1.03 (0.96–1.11)
IUGR (10th percentile)	1.5	122 (81.9)	0.99 (0.92–1.07)	0.9	39 (83.0)	0.97 (0.85–1.11)	1.3	161 (82.1)	0.99 (0.92–1.05)
LGA (90th percentile)	1.8	161 (85.2)	1.03 (0.97–1.10)	1.5	64 (84.2)	0.99 (0.90–1.09)	1.7	225 (84.9)	1.02 (0.97–1.07)
Premature rupture of membrane	1.8	101 (54.3)	0.66 (0.58–0.75)	1.7	58 (63.7)	0.75 (0.64–0.87)	1.8	159 (57.4)	0.69 (0.62–0.76)
Placenta previa	0.4	40 (93.0)	1.13 (1.04–1.23)	0.8	39 (90.7)	1.06 (0.97–1.17)	0.6	79 (91.9)	1.1 (1.03–1.17)
Placental abruption	0.4	36 (90.0)	1.09 (0.98–1.21)	0.2	8 (72.7)	0.85 (0.59–1.22)	0.3	44 (86.3)	1.04 (0.93–1.16)
Missing data, n		272			123			395	

*Robson group 5 represents women with a multiparous, singleton, cephalic, ≥ 37 weeks pregnancy, with a previous CS

Table 6. Caesarean rate in Robson group 2 by maternal age, maternal health condition, and obstetric complication for Ontario, 2011–2012*

	Maternal age								
	20 to 34 years (n= 13 239)			≥ 35 years (n= 2689)			All age groups (n= 15 928)		
	Prevelance, %	Caesarean sections, n (%)	Relative risk RR (95% CI)	Prevelance, %	Caesarean sections, n (%)	Relative risk RR (95% CI)	Prevelance, %	Caesarean sections, n (%)	Relative risk RR (95% CI)
Maternal health conditions									
Chronic hypertension	1.0	61 (46.6)	1.35 (1.12–1.62)	2.7	41 (56.9)	1.09 (0.89–1.34)	1.3	102 (50.2)	1.34 (1.17–1.54)
Diabetes mellitus type 1 and 2	2.3	139 (44.8)	1.30 (1.14–1.47)	4.4	68 (57.6)	1.10 (0.94–1.29)	2.7	207 (48.4)	1.29 (1.17–1.43)
Cardiac disease	0.6	37 (43.0)	1.24 (0.97–1.59)	0.9	10 (41.7)	0.80 (0.50–1.28)	0.7	47 (42.7)	1.14 (0.92–1.42)
Missing data, n		347			46			393	
Obstetrical complications									
Gestational diabetes	6.3	305 (36.6)	1.05 (0.96–1.16)	11.7	173 (55.1)	1.08 (0.97–1.21)	7.2	478 (41.7)	1.12 (1.04–1.20)
Gestational hypertension	9.2	421 (34.7)	1.00 (0.92–1.09)	8.9	127 (52.9)	1.04 (0.91–1.18)	9.1	548 (37.7)	1.01 (0.94–1.09)
Preeclampsia	5.4	243 (33.9)	0.98 (0.88–1.09)	5.9	86 (54.1)	1.06 (0.91–1.23)	5.5	329 (37.6)	1.01 (0.92–1.10)
IUGR (10th percentile)	5.0	159 (23.9)	0.69 (0.60–0.79)	4.1	39 (35.8)	0.70 (0.54–0.91)	4.9	198 (25.6)	0.69 (0.61–0.78)
LGA (90th percentile)	3.1	259 (64.0)	1.84 (1.70–1.99)	3.8	83 (80.6)	1.58 (1.42–1.76)	3.2	342 (67.3)	1.81 (1.69–1.93)
Premature rupture of membrane	7.0	235 (25.4)	0.73 (0.65–0.82)	6.3	68 (40.2)	0.79 (0.65–0.96)	6.9	303 (27.6)	0.74 (0.67–0.82)
Placenta previa	0.9	107 (93.0)	2.68 (2.53–2.84)	1.6	42 (95.5)	1.87 (1.73–2.03)	1.0	149 (93.7)	2.52 (2.40–2.64)
Placental abruption	0.4	33 (57.9)	1.67 (1.33–2.09)	0.6	8 (53.3)	1.05 (0.65–1.68)	0.5	41 (56.9)	1.53 (1.25–1.87)
Missing data, n		153			31			184	

*Robson group 2 represents nulliparous women with singleton, cephalic, and ≥ 37 weeks pregnancy, induced labour or CS before labour

provincial, national, and international levels.[11,14–19–22] We took classification of Caesarean sections using the Robson system one step further by analyzing records from each Robson classification group based on maternal age, behaviours, socioeconomic factors, health conditions, and obstetrical complications, to try to elucidate risk factors leading to higher rates of CS in mothers of advanced age. Consistent with findings from other studies, we showed that women who had a previous CS, classified into Robson group 5, made the largest contribution to the overall CS rate.[14,15,17–19,21] Only one other study[21] has reported carrying out further analysis of records classified using the Robson system by maternal age. The results from that study were consistent with those shown here except that the Robson group making the third largest contribution to the overall CS rate in women 40 and older was Robson group 8 (multiple gestation pregnancies),[21] whereas in our study Robson group 7 (multiparous, singleton, breech-presenting) was the third largest contributor for this age group.

Limitations of this study included the inability to classify 8721 women (6.5%) into Robson groups because of missing data, and the need to merge records from the two advanced maternal age groups for the analysis following Robson classification to prevent the risk of re-identification because of small cell size. The BORN Ontario group had previously conducted a data quality audit and validation study showing that a subset of the 2008 BORN data was of high quality.[23] The quality of the BORN data has continued to improve since then. Because we used a large cohort representing 134 088 deliveries, any coding errors that might have been introduced in the study would likely not alter study results. Lastly, the preferences of patients and health care providers could not be considered in evaluating the process of decision-making about delivery type because these preferences were not recorded during this study period. Since April 1, 2012, these data have been collected by BORN Ontario, and subsequent analysis of the impact of health care provider and maternal delivery preferences on CS rates will be possible.

CONCLUSION

Our findings reinforce the evidence that CS rates increase with advancing maternal age; however, we found that while mothers 35 and older had a higher overall prevalence of maternal health conditions and obstetrical complications, these women still have higher CS rates compared to mothers aged 20 to 34 with the same health condition(s) or obstetrical complication(s). Maternal health conditions and obstetrical complications associated with increased CS rates

Table 7. Caesarean section rates in women by maternal health condition, obstetrical complication, and age group in Ontario, 2011 to 2012*

	Maternal age								
	20 to 34 years (n = 25 885)			≥ 35 years (n = 3673)			All age groups (n = 29 558)		
	Prevalence, %	Caesarean sections, n (%)	Relative risk RR (95% CI)	Prevalence, %	Caesarean sections, n (%)	Relative risk RR (95% CI)	Prevalence, %	Caesarean sections, n (%)	Relative risk RR (95% CI)
Maternal health conditions									
Chronic hypertension	0.3	18 (26.5)	1.80 (1.21–2.68)	0.6	6 (26.1)	1.11 (0.56–2.22)	0.3	24 (26.4)	1.67 (1.18–2.36)
Diabetes mellitus type 1 and 2	0.6	28 (17.7)	1.20 (0.86–1.69)	1.2	10 (22.2)	0.95 (0.55–1.65)	0.7	38 (18.7)	1.19 (0.89–1.58)
Cardiac disease	0.4	16 (17.0)	1.16 (0.74–1.81)	0.5	6 (33.3)	1.42 (0.74–2.75)	0.4	22 (19.6)	1.24 (0.85–1.81)
Missing data, n		585			53			638	
Obstetrical complications									
Gestational diabetes	2.2	87 (15.5)	1.11 (0.91–1.35)	4.9	31 (17.2)	0.75 (0.54–1.04)	2.5	118 (15.9)	1.06 (0.89–1.25)
Gestational hypertension	1.7	97 (22.4)	1.60 (1.34–1.91)	1.9	23 (33.3)	1.46 (1.04–2.05)	1.7	120 (23.9)	1.59 (1.35–1.86)
Preeclampsia	0.3	16 (22.2)	1.59 (1.03–2.45)	0.4	7 (43.8)	1.91 (1.09–3.35)	0.3	23 (26.1)	1.74 (1.22–2.47)
IUGR (10th percentile)	0.9	30 (12.7)	0.91 (0.65–1.27)	0.8	9 (30.0)	1.31 (0.76–2.28)	0.9	39 (14.7)	0.97 (0.73–1.30)
LGA (90th percentile)	0.8	97 (44.1)	3.15 (2.71–3.67)	0.7	20 (74.1)	3.24 (2.57–4.09)	0.8	117 (47.4)	3.14 (2.75–3.60)
Premature rupture of membrane	3.6	166 (17.7)	1.27 (1.10–1.46)	3.9	34 (23.4)	1.03 (0.76–1.39)	3.7	200 (18.5)	1.23 (1.08–1.40)
Placenta previa	ND	ND	ND	ND	ND	ND	ND	ND	ND
Placental abruption	0.2	30 (53.6)	3.83 (2.99–4.89)	0.5	12 (63.2)	2.76 (1.95–3.92)	0.3	42 (56.0)	3.72 (3.04–4.55)
Missing data, n		321			33			354	

*Robson group 1 represents nulliparous women with singleton, cephalic, ≥ 37 weeks, spontaneous labour

ND: Not done because of cell size < 6; IUGR: intrauterine growth restriction; LGA: large for gestational age

with advancing maternal age were previous CS, primiparity, assisted reproductive technology, chronic hypertension, gestational diabetes, diabetes mellitus, preeclampsia, LGA, placenta previa, and placental abruption. Maternal smoking during pregnancy and socioeconomic status had no impact on the rate of CS.

Our use of the Robson classification system illustrates that this is a straightforward and replicable surveillance tool for examining CS rates and for identifying potential target groups to reduce these rates. In addition, it provides a classification framework to further examine the differences in maternal demographics, health conditions, or obstetrical complications unrelated to type of delivery presentation, as was shown in this study.

ACKNOWLEDGEMENTS

Mark Walker is supported by a University of Ottawa Tier 1 chair in perinatal epidemiology.

REFERENCES

1. Mathews, TJ, Hamilton BE. Delayed childbearing: more women are having their first child later in life. NCHS Data Brief no. 21, August 2009. Atlanta GA: Centers for Disease Control and Prevention; 2009. Available at: http://www.cdc.gov/nchs/data/databriefs/db21.pdf. Accessed August 26, 2013.
2. Statistics Canada. The children of older first-time mothers in Canada: their health and development. Children and youth research paper series. Ottawa ON: Statistics Canada; 2008. Catalogue number 89–599-M.
3. Benzies K, Tough S, Tofflemire K, Frick C, Faber A, Newburn-Cook C. Factors influencing women's decisions about timing of motherhood. J Obstet Gynecol Neonatal Nurs 2006 Sep-Oct;35(5):625–33.
4. Hoyert DL, Danel I, Tully P. Maternal mortality, United States and Canada, 1982–1997. Birth 2007;27:4–11.
5. Cleary-Goldman J, Malone FD, Vidaver J, Ball RH, Nyberg DA, Comstock CH, et al. Impact of maternal age on obstetric outcome. Obstet Gynecol 2005;105(5 Pt 1):983–90.
6. Huang L, Sauve R, Birkett N, Fergusson D, van Walraven C. Maternal age and risk of stillbirth: a systematic review. CMAJ 2008;178(2):165–72.
7. Jacobsson B, Ladfors L, Milsom I. Advanced maternal age and adverse perinatal outcome. Obstet Gynecol 2004;104(4):727–33.
8. Bayrampour H, Heaman M. Advanced maternal age and the risk of cesarean birth: a systematic review. Birth 2010;37(3):219–26.
9. Zasloff E, Schytt E, Waldenstrom U. First time mothers' pregnancy and birth experiences varying by age. Acta Obstet Gynecol Scand 2007;86(11):1328–36.
10. Fell DB, Joseph KS, Dodds L, Allen AC, Jangaard K, Van den Hof M. Changes in maternal characteristics in Nova Scotia, Canada from 1988 to 2001. Can J Public Health 2005;96(3):234–8.
11. Robson M. Classification of caesarean sections. Fetal Matern Med Rev 2001;12(1):23–39.
12. Pampalon R, Hamel D, Gamache P, Raymond G. A deprivation index for health planning in Canada. Chronic Dis Can 2009;29(4):178–91.
13. Farine D, Shepherd D. Classification of Caesarean sections in Canada: the modified Robson criteria. J Obstet Gynaecol Can 2012;34(10):976–9.
14. Kazmi T, Saiseema S5, Khan S. Analysis of cesarean section rate—according to Robson's 10-group classification. Oman Med J 2012;27(5):415–7.
15. Betrán AP, Gulmezoglu AM, Robson M, Merialdi M, Souza JP, Wojdyla D, et al. WHO global survey on maternal and perinatal health in Latin America: classifying caesarean sections. Reprod Health 2009;6:18. doi: 10.1186/1742–4755–6–18.
16. Robson MS, Scudamore IW, Walsh SM. Using the medical audit cycle to reduce cesarean section rates. Am J Obstet Gynecol 1996;174(1 Pt 1):199–205.
17. Brennan DJ, Robson MS, Murphy M, O'Herlihy C. Comparative analysis of international cesarean delivery rates using 10-group classification identifies significant variation in spontaneous labor. Am J Obstet Gynecol 2009;201(3):308, e1–e8.
18. Perinatal Services BC. Examining cesarean delivery rates in British Columbia using the Robson ten classification. Part 1: understanding the ten groups. A Perinatal Services BC surveillance special report. Vancouver BC: Perinatal Services BC; 2011;1(4). Available at: http://www.perinatalservicesbc.ca/NR/rdonlyres/3CE464BF-3538–4A78-BA51–451987FDD2EF/0/SurveillanceSpecialReportRobsonTenClassificationDec2011.pdf. Accessed August 8, 2013.
19. Kelly S, Sprague A, Fell DB, Murphy P, Aelicks N, Guo Y, et al. Examining Caesarean section rates in Canada using the Robson classification system. J Obstet Gynaecol Can 2013;35(3):206–14.
20. Betrán AP, Vindevoghel N, Souza JP, Gülmezoglu AM, Torloni MR. A systematic review of the Robson classification for caesarean section: what works, doesn't work and how to improve it. PLoS One 2014;9(6):e97769. doi:10.1371/journal.pone.0097769.
21. Grunebaum A, Lin S, Greenwood E, Lehman A. The contribution of patient age to the Robson cesarean section classification. Am J Obstet Gynecol 2012;206(1):S287–8.
22. Robson M, Hartigan L, Murphy M. Methods of achieving and maintaining an appropriate caesarean section rate. Best Pract Res Clin Obstet Gynaecol 2013;27(2):297–308.
23. Dunn S, Bottomley J, Ali A, Walker M. 2008 Niday perinatal database quality audit: report of a quality assurance project. Chronic Dis Inj Can 2011;32(1):32–42.