ARTICLE

A Population-Based Sample Comparing Birth Outcomes Between Different Models of Prenatal Care

Échantillon représentatif de la population comparant les issues de grossesse entre différents modèles de soins prénatals

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ABSTRACT

Objectives: To compare the sociodemographic and health characteristics of pregnant individuals, based on the model of prenatal care received, and to assess differences in low birth weight (LBW), preterm birth, and macrosomia between models of prenatal care.

Methods: This retrospective cohort study consisted of a sample of 23,529 pregnant individuals from Southwestern Ontario and their birth outcomes between February 2009 and February 2014. Logistic regression models assessed the relationship between type of prenatal care provider and adverse birth outcomes.

Results: Most individuals (39.9%) received care by a family physician and obstetrician/gynecologist; 36.2% by an obstetrician/gynecologist only; 13.4% by a family physician only; 7.6% by a midwife only; 1.8% by a midwife and obstetrician/gynecologist; and 1.0% by a midwife and family physician. Patients receiving midwife-led care only were older and had higher neighbourhood-level income than patients seen by other models of care ($p < .001$). Patients seen by obstetricians/gynecologists only had the highest odds for LBW (aOR 1.42; 95% CI 1.13, 1.18) compared to care where midwives were involved at any point during pregnancy. However, midwife involvement in care had the highest odds for macrosomia compared to those without midwife involvement.

Conclusion: Patients receiving prenatal care by a midwife were older, had higher incomes, had a lower prevalence of LBW infants, but greater odds for fetal macrosomia, compared to other models of care.

KEYWORDS

midwifery, prenatal care, low birth weight, premature birth, fetal macrosomia, pregnancy

This article has been peer reviewed.

RÉSUMÉ

Objectifs : Comparer les caractéristiques sociodémographiques et sanitaires des personnes enceintes en fonction du modèle de soins prénatals reçu et évaluer les différences entre ces modèles au chapitre du faible poids à la naissance, de la prématurité et de la macrosomie.

Méthodes : Cette étude de cohorte rétrospective a porté sur un échantillon de 23 529 personnes enceintes du Sud-Ouest de l'Ontario et l'issue de leur grossesse entre février 2009 et février 2014. Des modèles de régression logistique ont évalué les relations entre le type de fournisseur de soins prénatals et les issues de grossesse indésirables.

Résultats : La plupart des personnes (39,9 %) ont reçu les soins d'un médecin de famille et d'un obstétricien-gynécologue; 36,2 %, d'un obstétricien-gynécologique seulement; 13,4 %, d'un médecin de famille seulement; 7,6 % d'une sage-femme seulement; 1,8 %, d'une sage-femme et d'un obstétricien-gynécologue; 1,0 %, d'une sage-femme et d'un médecin de famille. La clientèle qui a reçu des soins d'une sage-femme seulement était plus âgée et habitait des quartiers dont le revenu était plus élevé par rapport aux personnes ayant bénéficié d'autres modèles de soins ($p < 0,001$). Les nouveau-nés des personnes suivies par des obstétriciens-gynécologues seulement ont été les plus susceptibles de présenter un faible poids à la naissance (RCa = 1,42; IC à 95 % = 1,13, 1,18) par rapport à ceux nés d'individus qui avaient obtenu des soins d'une sage-femme à n'importe quel stade de la grossesse. Cependant, la participation d'une sage-femme aux soins est associée à la plus grande susceptibilité à la macrosomie.

Conclusion : Par comparaison à celles qui avaient bénéficié d'autres modèles de soins, les personnes qui avaient été vues par une sage-femme étaient plus âgées, avaient un revenu plus élevé et avaient connu une plus faible prévalence de nouveau-nés présentant un faible poids à la naissance, mais les risques de macrosomie fœtale étaient plus élevés.

MOTS-CLÉS
pratique sage-femme, soins prénatals, faible poids à la naissance, naissance prématurée, macrosomie fœtale, grossesse

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INTRODUCTION

In Canada, pregnant individuals can self-select three primary prenatal care providers: family physicians, obstetrician/gynecologists, and midwives.[1] The demand for midwives is rising, as midwifery care and attended births have consistently increased across the country, more than tripling from 3% in 2001 to 11% in 2019.[2,3] Many studies report that midwifery care has positive effects on pregnancy outcomes, but few directly compare midwifery care to other models of prenatal care.[4–6] A Cochrane Review of 15 randomized controlled trials found that, when compared to care by obstetricians, family physicians, and shared care models, a midwife-led continuity of care was associated with a lower risk of preterm birth (PTB), fetal loss, and neonatal death; a higher likelihood of spontaneous vaginal birth; and a longer period of labour.[6] A 2018 retrospective cohort study of 8,779 individuals with low-risk pregnancies in the United States found that persons in midwifery care had lower risks of PTB (adjusted risk ratio [aRR] 0.58; 95% CI 0.42–0.79) and cesarean deliveries (aRR 0.66; 95% CI 0.57–0.78) than did persons who received care from physicians.[4] Comparing midwifery-led care to obstetrician-led care of low-risk persons, the United Kingdom's National Institute for Health and Care Excellence found that midwifery-led care was associated with lower rates of intervention and comparable infant outcomes.[5]

Despite the benefits of midwifery-led care, studies should consider the extent to which self-selection into midwifery care leads to covariate imbalance in key prognostic indicators of infant health outcomes between individuals in midwife-led versus physician-led care. Without randomized controlled trials or the use of multivariate statistics to adjust for confounding variables, it is unclear whether midwifery-led care per se is driving more optimal neonatal outcomes or whether individuals who receive midwifery care have a more favourable health status than individuals receiving care by physicians, resulting in more advantageous neonatal outcomes. A study comparing physician-led care to midwifery care in an Ohio hospital found that persons in midwifery care were less likely to be Black, less likely to smoke during pregnancy, less likely to have had a previous cesarean birth, and more likely to be married and of advanced maternal age.[4] These characteristics are inconsistent with those found in a Canadian study, which showed that individuals who received prenatal care from a midwife were more likely to be Indigenous, to consume alcohol during pregnancy, and to have a higher education than individuals who received care from other health care providers (HCPs).[7]

High birth weight and low birth weight are considered adverse birth outcomes and are commonly reported as fetal macrosomia and low birth weight, respectively.[8] Low birth weight (LBW) is usually caused by premature birth, although some babies are LBW at full term. Macrosomia increases maternal risk of cesarean delivery, postpartum hemorrhage and vaginal lacerations, and infant risk for shoulder dystocia, clavicle fractures, brachial plexus injury, and admissions to the neonatal intensive care unit.[9] Obesity is a risk factor for macrosomia, and the increasing rates of obesity in Canada will affect the types of care and interventions that are needed at birth, which are important considerations in midwifery training.[10,11] Another adverse birth outcome is PTB, which is the leading cause of perinatal mortality and is associated with developmental problems and adverse health outcomes in adulthood.[9–11] In Canada, PTB occurs in 8% of pregnancies and costs the health care system over $8 billion annually.[10,12]

OBJECTIVES

This study used a sample of pregnant individuals from Southwestern Ontario and had two objectives: (1) to compare the sociodemographic and health characteristics of patients in midwife-led care, obstetrician/gynecologist-led care, family physician–led care, and shared care, and (2) to compare differences in LBW, PTB, and macrosomia, based on the model of care received by pregnant individuals and adjusting for medical factors (gestational diabetes, pre-pregnancy body mass index, depression, anxiety, previous PTB, or previous C-section), behavioural factors (use of tobacco, alcohol, marijuana, prescription drugs, and natural health products during pregnancy), maternal age, and neighbourhood income.

METHODS

This retrospective, population-based cohort study consisted of a large sample of pregnant individuals and their birth outcomes between February 2009 and February 2014 at London Health Sciences Centre in London, Ontario, Canada. London Health Sciences Centre (LHSC) is a tertiary referral hospital that sees 1.5 million patients annually. Prior to 2011, St. Joseph's Health Care was the tertiary care centre, which had a large catchment area that included Thunder Bay. Data from both centres were combined in a central perinatal database that was used in this study. Data were obtained from the neonatal and perinatal databases at LHSC and included variables pertaining to demographics, prenatal provider, medical history, pregnancy complications, risk-taking behaviour, and birth outcomes. All births were prospectively entered from medical charts, and a research assistant logged all births and neonatal records.[12] Individuals who gave birth to singleton newborns without congenital anomalies were included in the study.

To determine the characteristics of patients seen by different health care providers, the researchers grouped patients into six categories based on who the patient had seen for care: (1) midwife only, (2) family physician only, (3) obstetrician/gynecologist (OB/GYN) only, (4) midwife and OB/GYN, (5) family physician and OB/GYN, and (6) midwife and family physician. Given that midwives fell into three categories, a separate analysis was conducted comparing any midwife involvement in prenatal care with family physician care only, OB/GYN care only, and care shared between a family physician and an OB/GYN. Low birth rate was defined as <2500 g (< 5.5 lb.) at birth regardless of gestational age, PTB as a live birth at < 37 weeks' gestational age, and fetal macrosomia as a birth weight of > 4000 g (> 8.8 lb.).

Six-digit postal codes were also collected during pregnancy. Postal codes were geocoded and mapped with a geographic information system (ArcGIS 10.4 [ESRI, Redlands, CA]) to obtain neighbourhood-level income extracted from the 2011 National Household Survey.[13] Neighbourhood income was obtained based on the census dissemination area within which each patient's postal code fell. Neighbourhood socioeconomic status was determined by using a low-income measure after tax: the percentage of the dissemination area population in 2011 who were deemed to be low income, based on after-tax income in 2010.

The study received approval from the Health Science Research Ethics Board at Western University (approval #113051).

STATISTICAL ANALYSIS

Data were analyzed with SPSS version 25.0 (IBM Corp., Armonk, NY). Continuous variables were summarized, using the mean and standard deviation or the median and interquartile range where appropriate. Percentages were used to summarize categorical variables. One-way analysis of variance (ANOVA) compared differences in means between the HCP groups, and the chi-square test compared differences in proportions.

Logistic regression models assessed the strength of the relationship between the type of HCP seen during pregnancy and LBW, PTB, and macrosomia, after adjusting for other covariates also correlated with these outcomes in bivariate analyses ($p < .10$). Confounding factors included in our multivariable models were selected based on evidence from the literature[14]–maternal age, income, previous PTB, previous cesarean delivery, anxiety, depression, tobacco use, marijuana use, alcohol use, natural health product use, prescription drug use, gestational diabetes, and pre-pregnancy body mass index (BMI). Maternal age and income were measured on a continuous scale, whereas all

other variables were binary (yes/no), except for BMI, which was on an ordinal scale. Categories for BMI reflect the World Health Organization classification, where < 18.5 indicates underweight; 18.5 to < 25, normal weight; 25 to < 30, overweight; and ≥ 30, obese.[15]

Since logistic regression is sensitive to high correlations among the independent variables, multicollinearity was assessed by including the same variables used in the logistic regressions in multiple linear regressions to obtain collinearity diagnostics (i.e., tolerance statistic, variance inflation factor, condition index). There were no high intercorrelations among the independent variables. As there were very little to no missing data for all variables, any data that were missing were excluded in our regression models through listwise deletion. Both crude and adjusted odds ratios (ORs) with 95% confidence intervals (CIs) are provided for the regression models. A *p* value of < .05 was considered statistically significant.

RESULTS

Objective 1

Data on prenatal care providers were available for 23,529 individuals (91% of the sample). Of these pregnant individuals, 39.9% were seen by a family physician and an OB/GYN, 36.2% by an OB/GYN only, 13.4% by a family physician only, 7.6% by a midwife only, 1.8% by a midwife and an OB/GYN, and 1.0% by a midwife and a family physician. Patients receiving prenatal care from a midwife only were older and had higher incomes than patients who were receiving care from other HCPs ($p < .001$) (Table 1). Teenage pregnant individuals were least likely to receive care from a midwife only (1.5%) and most likely to receive care from a family physician only (6.0%) ($p < .001$). Individuals with an obese pre-pregnancy BMI were most likely to receive care from an OB/GYN only (20.6%) and least likely to be receiving care from a midwife and a family physician (14.8%) ($p < .001$). Pregnant individuals who received care from a midwife and a family physician had the highest intention to breastfeed (99.1%), whereas those who received care from an OB/GYN only had the lowest intention (89.1%) ($p < .001$).

Table 2 compares risk-taking behaviour and health characteristics between patients seeing different HCPs. Patients who were seeing only midwives had the lowest tobacco (4.9%), alcohol (1.1%), and marijuana (0.6%) use during pregnancy, whereas those receiving care from only a family physician had the highest use of those substances (20.1%, 2.5%, and 3.7%, respectively) ($p < .05$). Depression during pregnancy was least common

Table 1. Characteristics of Patients with a Singleton Hospital Birth from February 2009 to February 2014, by Prenatal Health Care Provider

Variable*	Midwife Only (*n*=1,789)	Family Physician Only (*n*=3,163)	OB/GYN Only (*n*=8,519)	Midwife + OB/GYN (*n*=426)	Family Physician + OB/GYN (*n*=9,389)	Midwife + Family Physician (*n*=243)	*p*Value
Maternal age	30.2 ± 4.6	28.5 ± 5.5	29.4 ± 5.7	30.0 ± 5.4	29.5 ± 5.3	29.7 ± 4.4	< .001
≥ 35 years (%)	17.3	13.6	18.3	20.9	17.2	11.9	< .001
≤ 19 years (%)	1.5	6.0	4.8	3.1	3.9	1.6	< .001
Pre-pregnancy BMI	24.7 ± 5.3	25.0 ± 5.8	25.8 ± 6.5	26.0 ± 6.6	25.7 ± 6.2	24.5 ± 5.3	< .001
Underweight (%)	4.2	5.1	5.2	2.6	4.5	4.0	
Normal weight (%)	61.1	55.2	50.8	53.6	51.7	64.1	

OB/GYN, obstetrician-gynecologist
One-way analysis of variance (ANOVA) was used to compare mean differences in continuous variables between the groups, and the chi-square test was used to compare differences in proportions for categorical outcomes. Data are reported as percentages (%) or as mean ± standard deviation (SD).

Table 2. Risk-Taking Behaviour and Health Profile of Patients Seen by Different Health Care Providers

Variable*	Midwife Only (*n*=1,789)	Family Physian Only (*n*=3,163)	OB/GYN Only (*n*=8,519)	Midwife + OB/GYN (*n*=426)	Family Physician + OB/GYN (*n*=9,389)	Midwife + Family	*p*Value
Tobacco use (%)	4.9	20.1	17.5	10.6	15.3	10	< .001
Marijuana use (%)	0.6	3.7	2.5	0.2	1.8	0.8	< 0.001
Alcohol use (%)	1.1	2.5	1.7	1.6	1.9	1.6	0.02
Depression (%)	4.5	7.2	5.3	4.9	6.4	4.9	< .001
Anxiety (%)	5.3	3.9	3.8	5.6	4.9	7.0	< .001
Gestational diabetes (%)	1.3	2.2	4.9	6.3	4.5	1.6	< .001
Previous PTB (%)	4.0	4.5	8.7	8.2	5.4	2.9	< .001
Previous CS (%)	3.8	5.9	29.9	12.7	17.7	6.8	< .001
Prescription use (%)	27.8	29.7	31.6	40.1	34.5	28.8	< .001
Natural health product use (%)	6.0	2.5	1.4	9.2	3.5	7.8	< .001

CS, cesarean section; OB/GYN, obstetrician-gynecologist; PTB, preterm birth
*The chi-square test was used to compare differences in proportions for all categorical outcomes.

among patients seeing a midwife only (4.5%) and most common among individuals who saw a family physician only (7.2%) ($p < .001$). Gestational diabetes and prescription drug use was least common in individuals receiving midwife-led care only and most common in individuals seen by both a midwife and an OB/GYN ($p < .001$).

Objective 2

Table 3 shows the association between the type of prenatal care received and neonatal outcomes. Rates of LBW varied between 2.4% and 9.6%; the lowest rate was for individuals seen exclusively by midwives, and the highest rate was for those who received care by a midwife and an OB/GYN ($p < .001$). Individuals in only midwife-led care had the lowest odds of PTB (4.5%); the highest odds were those of individuals seen by a midwife and an OB/GYN (12.2%) ($p < .001$). However, odds for macrosomia were high in patients receiving care in any model in which midwives were involved; 18.5% of persons seen by both a midwife and a family physician and 18.1% of those seen exclusively by midwives had a macrosomic baby, compared to 10.3% of pregnant individuals who were seen by family physicians only and 10.9% seen by an OB/GYN only ($p < .001$).

Table 4 presents the results of the logistic regression models. Individuals whose only HCP was a midwife had the lowest odds for LBW and PTB, whereas those who saw a midwife and an OB/GYN had the highest odds for these outcomes. When shared care involved a midwife and an OB/GYN, the odds were 3.79 (95% CI 2.42, 5.95) and 2.53 (95% CI 1.74, 3.68) for LBW and PTB, respectively, compared to individuals receiving primary care by midwives only, adjusting for all other covariates. Individuals who had a previous PTB were three times more likely to have a low-birth-weight infant regardless of their prenatal care provider (aOR 3.07; 95% CI 2.59, 3.62) and four times more likely to have another PTB (aOR 4.07; 95% CI 3.53, 4.70). Marijuana use during pregnancy more than doubled the odds of having a low-birth-weight infant (aOR 2.27; 95% CI 1.70, 3.02).

Individuals who received midwife-led care had the highest odds for macrosomia. For example, individuals who received their prenatal care from family physicians only were 43% less likely to have a macrosomic baby (aOR 0.57; 95% CI 0.48, 0.68) than were individuals receiving care from midwives

Table 3. Neonatal Outcomes of Patients by Type of Health Care Provider

Variable*	Midwife Only (n=1,789)	Family Physician Only (n=3,163)	OB/GYN Only (n=8,519)	Midwife + OB/GYN (n=426)	Family Physician + OB/GYN (n=9,389)	Midwife + Family Physician (n=243)	*p*Value
Birth weight (g)	3568.2 ± 501.2	3376 ± 538.3	3366.6 ± 590.7	3353.9 ± 691.1	3395.4 ± 551.9	3549 ± 546.3	< .001
LBW (%)	2.4	4.6	6.3	9.6	4.9	2.9	< .001
Gestational age (weeks)	39.4 ± 1.5	38.9 ± 2.0	38.7 ± 2.2	38.6 ± 2.5	39.0 ± 1.9	39.4 ± 1.8	< .001
PTB (%)	4.5	5.8	8.2	12.2	6.2	5.3	< .001
Macrosomia (%)	18.1	10.3	10.9	14.8	11.3	18.5	< .001

LBW, low birth weight; OB/GYN, obstetrician-gynecologist; PTB, preterm birth
*One-way analysis of variance (ANOVA) was used to compare mean differences in continuous variables between the groups. The chi-square test was used to compare differences in proportions for categorical outcomes. Data are reported as percentages (%) or mean ± standard deviation (SD).

only, controlling for all other variables. Obstetrician-led care and care shared by a family physician and an OB/GYN were associated with 40% lower odds for macrosomia compared with midwifery-led care. A pre-pregnancy BMI of overweight (aOR 1.47; 95% CI 1.32, 1.63) and obese (aOR 1.80; 95% CI 1.61, 2.02) increased the odds for macrosomia, adjusting for all other covariates.

Table 5 compares any midwife involvement in prenatal care to other models of care. While patients who saw only an OB/GYN were 1.4 times more likely to have a low-birth-weight infant than patients who received any care from a midwife (aOR 1.42; 95% CI 1.13, 1.80), neither physician-led care by a family physician nor care shared between a family physician and an OB/GYN were associated with higher odds for LBW, compared to care with midwife involvement. There was also no statistically significant association between the type of prenatal care received and PTB. Compared with individuals who received prenatal care with any midwife involvement, patients who received care by a family physicians, care by an OB/GYN, or care shared between a family physician and an OB/GYN were 38%–40% less likely to have a baby with macrosomia.

DISCUSSION

In this study, 10.4% of pregnant individuals had a midwife as one of their primary HCPs, which is close to the 2017 Canadian average of 9.8% but lower than the Ontario average of 15.2%.[16] The characteristics of midwife clients in this study were similar to those in other studies from Canada and the United States, which showed that persons in midwifery care are more likely to enter pregnancy with a normal BMI, have low rates of gestational diabetes and smoking during pregnancy, and are the least likely to have low incomes when compared with persons under other models of care.[1,4] However, these data are inconsistent with a Canadian study in which persons receiving midwifery care had higher rates of alcohol use and were more likely to be Indigenous.[7] Because the health characteristics of individuals may influence adverse birth outcomes between different models of care, the regression results were adjusted for individuals' health characteristics (e.g., pre-pregnancy BMI, gestational diabetes, smoking during pregnancy) to determine a better estimate of LBW, PTB, and macrosomia, based on the model of care received during pregnancy.

Individuals seen by only a midwife had the lowest prevalence of LBW and PTB. When all other characteristics were accounted for in the regression model, the low odds for LBW in midwifery-only care persisted when compared with other models of care, except for care shared by a family physician and a midwife. There was no difference in the prevalence of PTB between care with midwife involvement and care without midwife involvement. On the other

Table 4: Crude and Adjusted Odds Ratios of Logistic Regression Models Predicting Low Birth Weight, Preterm Birth, and Macrosomia

Predicator Variables	LBW *				PTB *				Macrosomia *			
	Crude OR	95% CI	Adjusted OR	95% CI	Crude OR	95% CI	Adjusted OR	95% CI	Crude OR	95% CI	Adjusted OR	95% CI
Prenatal care provider												
MW only†	1.00		1.00		1.00		1.00		1.00		1.00	
FP only	**1.94**	**[1.37, 2.74]**	**1.51**	**[1.06, 2.15]**	**1.33**	**[1.01, 1.74]**	1.18	[0.89, 1.55]	**0.52**	**[0.44, 0.61]**	**0.57**	**[0.48, 0.68]**
OB/GYN only	**2.74**	**[2.00, 3.75]**	**2.14**	**[1.56, 2.95]**	**1.90**	**[1.50, 2.41]**	**1.55**	**[1.22, 1.98]**	**0.55**	**[0.48, 0.64]**	**0.60**	**[0.52, 0.69]**
MW + OB/GYN	**4.32**	**[2.78, 6.73]**	**3.79**	**[2.42, 5.95]**	**2.97**	**[2.06, 4.29]**	**2.53**	**[1.74, 3.68]**	0.79	[0.59, 1.06]	0.77	[0.57, 1.04]
FP + OB/GYN	**2.10**	**[1.53, 2.88]**	**1.79**	**[1.30, 2.47]**	**1.40**	**[1.10, 1.78]**	1.23	[0.97, 1.57]	**0.58**	**[0.50, 0.66]**	**0.60**	**[0.52, 0.69]**
MW + FP	1.20	[0.54, 2.71]	1.16	[0.52, 2.63]	1.21	[0.66, 2.21]	1.21	[0.66, 2.23]	1.03	[0.73, 1.45]	1.06	[0.74, 1.51]
Maternal age	**0.99**	**[0.98, 0.99]**	1.00	[0.98, 1.01]	1.00	[0.99, 1.00]	**0.99**	**[0.98, 0.99]**	**1.02**	**[1.01, 1.03]**	1.01	[1.00, 1.02]
Low income after tax	1.01	[1.00, 1.01]	1.00	[1.00, 1.01]	1.00	[1.00, 1.01]	1.00	[1.00, 1.00]	1.00	[1.00, 1.00]	1.00	[1.00, 1.00]
Previous PTB	**3.45**	**[2.99, 3.98]**	**3.07**	**[2.59, 3.62]**	**4.37**	**[3.86, 4.94]**	**4.07**	**[3.53, 4.70]**	**0.69**	**[0.58, 0.82]**	**0.65**	**[0.53, 0.79]**
Previous cesarean section	1.10	[1.00, 1.22]	0.90	[0.79, 1.02]	**1.18**	**[1.09, 1.29]**	0.94	[0.84, 1.05]	**1.13**	**[1.05, 1.21]**	1.07	[0.99, 1.17]
Anxiety this pregnancy	**1.29**	**[1.02, 1.63]**	0.97	[0.73, 1.28]	**1.52**	**[1.26, 1.85]**	**1.27**	**[1.01, 1.61]**	0.98	[0.81, 1.17]	1.02	[0.83, 1.27]
Depression this pregnancy	**1.27**	**[1.03, 1.56]**	0.93	[0.72, 1.19]	**1.34**	**[1.12, 1.60]**	0.97	[0.78, 1.21]	0.85	[0.72, 1.01]	**0.80**	**[0.66, 0.98]**
Tobacco use	**1.96**	**[1.73, 2.21]**	**1.57**	**[1.35, 1.82]**	**1.32**	**[1.18, 1.49]**	1.02	[0.88, 1.19]	**0.58**	**[0.51, 0.65]**	**0.65**	**[0.57, 0.75]**
Marijuana use	**3.19**	**[2.52, 4.04]**	**2.27**	**[1.70, 3.02]**	**2.01**	**[1.57, 2.56**	**1.62**	**[1.19, 2.21]**	**0.51**	**[0.36, 0.71]**	0.79	[0.54, 1.15]
Alcohol use	1.30	[0.93, 1.82]	**0.64**	**[0.41, 0.99]**	1.07	[0.78, 1.48]	0.72	[0.47, 1.10]	0.92	[0.70, 1.23]	1.18	[0.85, 1.62]
Natural health products	**0.63**	**[0.43, 0.93]**	0.77	[0.51, 1.17]	**0.69**	**[0.50, 0.96]**	0.87	[0.62, 1.23]	0.89	[0.70, 1.13]	0.81	[0.63, 1.04]
Prescription drugs	**1.83**	**[1.64, 2.04]**	**1.76**	**[1.56, 1.99]**	**1.96**	**[1.78, 2.15]**	**1.77**	**[1.59, 1.98]**	0.98	[0.90, 1.06]	0.96	[0.88, 1.05]
Gestational diabetes	**1.47**	**[1.20, 1.80]**	**1.32**	**[1.02, 1.71]**	**2.15**	**[1.83, 2.52]**	**1.73**	**[1.40, 2.14]**	**1.76**	**[1.53, 2.03]**	**1.39**	**[1.16, 1.67]**
Body mass index												
Healthy weight†	1.00		1.00		1.00		1.00		1.00		1.00	
Underweight	**1.71**	**[1.36, 2.14]**	**1.72**	**[1.34, 2.22]**	1.12	[0.88, 1.42]	1.19	[0.92, 1.56]	**0.40**	**[0.29, 0.55]**	**0.44**	**[0.32, 0.61]**
Overweight	**0.72**	**[0.61, 0.85]**	**0.73**	**[0.61, 0.88]**	**0.86**	**[0.75, 0.99]**	0.87	[0.75, 1.02]	**1.49**	**[1.35, 1.66]**	**1.47**	**[1.32, 1.63]**
Obese	**0.83**	**[0.70, 0.99]**	**0.79**	**[0.65, 0.96]**	0.95	[0.82, 1.10]	0.90	[0.76, 1.06]	**1.90**	**[1.71, 2.11]**	**1.80**	**[1.61, 2.02]**

CI, confidence interval; FP, family physician; LBW, low birth weight; MW, midwife; OB/GYN, obstetrician/gynecologist; OR, odds ratio; PTB, preterm birth
*Bold denotes statistically significant odds ratio.
†Reference category

Table 5: Crude and Adjusted Odds Ratios of Logistic Regression Models Predicting Low Birth Weight, Preterm Birth, and Macrosomia

Predicator Variables	LBW *				PTB *				Macrosomia *			
	Crude OR	95% CI	Adjusted OR	95% CI	Crude OR	95% CI	Adjusted OR	95% CI	Crude OR	95% CI	Adjusted OR	95% CI
Prenatal care provider												
MW involved†	1.00		1.00		1.00		1.00		1.00		1.00	
FP only	1.24	[0.95, 1.62]	1.00	[0.76, 1.36]	0.99	[0.79, 1.24]	0.90	[0.71, 1.14]	**0.54**	**[0.46, 0.63]**	**0.60**	**[0.51, 0.70]**
OB/GYN only	**1.75**	**[1.40, 2.20]**	**1.42**	**[1.13, 1.80]**	**1.42**	**[1.18, 1.71]**	1.21	[1.00, 1.46]	**0.57**	**[0.51, 0.65]**	**0.62**	**[0.55, 0.71]**
FP + OB/GYN	**1.34**	**[1.07, 1.69]**	1.19	[0.94, 1.50]	1.05	[0.87, 1.26]	0.95	[0.79, 1.15]	**0.60**	**[0.53, 0.67]**	**0.62**	**[0.54, 0.70]**
Maternal age	**0.99**	**[0.98, 0.99]**	1.00	[0.99, 1.01]	1.00	[0.99, 1.00]	**0.99**	**[0.98, 0.99]**	**1.02**	**[1.01, 1.03]**	1.01	[1.00, 1.02]
Low income after tax	1.01	[1.00, 1.01]	1.00	[1.00, 1.01]	1.00	[1.00, 1.01]	1.00	[1.00, 1.00]	1.00	[1.00, 1.00]	1.00	[1.00, 1.00]
Previous PTB	**3.45**	**[2.99, 3.98]**	**3.20**	**[2.71, 3.79]**	**4.37**	**[3.86, 4.94]**	**4.18**	**[3.62, 4.83]**	**0.69**	**[0.58, 0.82]**	**0.64**	**[0.53, 0.78]**
Previous cesarean section	1.10	[1.00, 1.22]	**0.74**	**[0.61, 090]**	**1.18**	**[1.09, 1.29]**	**0.84**	**[0.72, 0.99]**	**1.13**	**[1.05, 1.21]**	**1.18**	**[1.05, 1.32]**
Anxiety this pregnancy	**1.29**	**[1.02, 1.63]**	0.97	[0.73, 1.28]	**1.52**	**[1.26, 1.85]**	**1.27**	**[1.01, 1.61]**	0.98	[0.81, 1.17]	1.02	[0.83, 1.27]
Depression this pregnancy	**1.27**	**[1.03, 1.56]**	0.93	[0.73, 1.20]	**1.34**	**[1.12, 1.60]**	0.97	[0.78, 1.21]	0.85	[0.72, 1.01]	**0.81**	**[0.66, 0.98]**
Tobacco use	**1.96**	**[1.73, 2.21]**	**1.57**	**[1.35, 1.83]**	**1.32**	**[1.18, 1.49]**	1.03	[0.89, 1.19]	0.58	[0.51, 0.65]	0.65	[0.57, 0.75]
Marijuana use	**3.19**	**[2.52, 4.04]**	**2.28**	**[1.71, 3.03]**	**2.01**	**[1.57, 2.56]**	**1.63**	**[1.20, 2.22]**	**0.51**	**[0.36, 0.71]**	0.79	[0.54, 1.16]
Alcohol use	1.30	[0.93, 1.82]	0.65	[0.41, 1.01]	1.07	[0.78, 1.48]	0.73	[0.48, 1.11]	0.92	[0.70, 1.23]	1.18	[0.85, 1.63]
Natural health products	**0.63**	**[0.43, 0.93]**	0.80	[0.52, 1.21]	**0.69**	**[0.50, 0.96]**	0.90	[0.64, 1.26]	0.89	[0.70, 1.13]	0.80	[0.62, 1.03]
Prescription drugs	**1.83**	**[1.64, 2.04]**	**1.78**	**[1.57, 2.02]**	**1.96**	**[1.78, 2.15]**	**1.78**	**[1.59, 1.98]**	0.98	[0.90, 1.06]	0.96	[0.88, 1.05]
Gestational diabetes	**1.47**	[1.20, 1.80]	**1.35**	**[1.04, 1.75]**	**2.15**	**[1.83, 2.52]**	**1.76**	**[1.43, 2.18]**	**1.76**	**[1.53, 2.03]**	**1.38**	**[1.15, 1.66]**
Body mass index												
Healthy weight†	1.00		1.00		1.00		1.00		1.00		1.00	
Underweight	**1.71**	**[1.36, 2.14]**	**1.71**	**[1.33, 2.20]**	1.12	[0.88, 1.42]	1.17	[0.90, 1.53]	**0.40**	**[0.29, 0.55]**	**0.44**	**[0.32, 0.61]**
Overweight	**0.72**	**[0.61, 0.85]**	**0.74**	**[0.61, 0.89]**	**0.86**	**[0.75, 0.99]**	0.89	[0.76, 1.04]	**1.49**	**[1.35, 1.66]**	**1.46**	**[1.31, 1.63]**
Obese	**0.83**	**[0.70, 0.99]**	**0.80**	**[0.65, 0.97]**	0.95	[0.82, 1.10]	0.92	[0.78, 1.09]	**1.90**	**[1.71, 2.11]**	**1.80**	**[1.61, 2.02]**

CI, confidence interval; FP, family physician; LBW, low birth weight; MW, midwife; OB/GYN, obstetrician/gynecologist; OR, odds ratio; PTB, preterm birth
*Bold denotes statistically significant odds ratio.
†Reference category

hand, when all models of care were compared, OB/GYN care had the highest odds for babies with LBW, which is associated with the development of hypertension, stroke, coronary heart disease, and metabolic syndrome later in life.[17–19] Although risk factors for LBW—such as socioeconomic influences, medical history, genetic and nongenetic factors, and a person's lifestyle before and during pregnancy—are vast and complex, studies indicate that regardless of confounding factors, adequate prenatal care decreases the risk of LBW.[20–25] A consistent difference between midwifery care and other models of prenatal care is the time spent with patients and clients. Compared with other HCPs, midwives spend more time on average with their clients at each visit, which suggests that midwives have more time to discuss issues related to increased risks during pregnancy, possibly contributing increased support for women and decreased risk for low-birth-weight infants in midwifery care.[26] Because midwifery care appears to be protective against LBW, it is critical to understand the aspects of midwifery care that lead to these protective benefits; this understanding can then be shared with other prenatal care providers to improve birth outcomes.

Interestingly, pregnant individuals who had any midwife involvement in their pregnancy had the highest odds of macrosomia as compared with other models of care. The adverse effects of macrosomia include perinatal death, admission to an intensive care unit, and later risks of childhood obesity, metabolic syndrome, and cardiovascular disease.[27] One of the risk factors for macrosomia is gestational weight gain (GWG). Studies indicate that persons who receive GWG advice from their HCPs during pregnancy have a lower likelihood of having a macrosomic baby.[28] Although midwives and obstetricians are reported to have a comparable knowledge of appropriate GWG, midwives report giving a low priority to GWG, as they may perceive discussions about weight to negatively affect a client's physical and psychological health.[29,30] It is possible that the low priority given to GWG may result in a greater-than-recommended weight gain during pregnancy, which in turn is contributing to macrosomic babies in midwifery care. Another risk factor for macrosomia is gestational diabetes.[9] Interestingly, midwifery clients had the lowest rate of gestational diabetes, but they also had the highest odds for macrosomia. Although under-reporting and testing of gestational diabetes are possible in midwifery care and could be influencing these results, there is no evidence that this occurred in our database.[31]

STRENGTHS AND LIMITATIONS

This study has a few limitations. First the study's data were limited to a single tertiary care centre: London Health Sciences Centre (LHSC) in London, Ontario. Practitioners from LHSC do not attend all births in Southwestern Ontario, even though LHSC is a referral centre for high-risk pregnancies from nearby regions. Therefore, generalizability beyond Southwestern Ontario is problematic. Second, data on substance use and mental health problems during pregnancy were limited to self-reported data, which likely led to under-reporting. Third, we do not know the extent of shared care among the HCPs and cannot predict how much and when each HCP provided care. Last, although our regression analysis accounted for 13 risk factors for adverse birth outcomes in pregnancy, we were not able to account for all possible risk factors, such as pregnancy risk type. These limitations notwithstanding, our study adds to the limited research comparing midwifery-led care to other models of care, examines the impact that the model of care has on adverse birth outcomes, has a large sample size, and was able to statistically adjust for many important confounding variables, including accounting for shared care and transfer of care from a midwife to an OB/GYN.

CONCLUSIONS

Midwifery care is on the rise in Canada, and now is the time to identify advantages associated with it to maximize benefits and minimize adverse birth outcomes. Evidence indicates that continuity of midwifery care is beneficial to clients, but how this translates to more optimal birth outcomes is unclear.[6] For example, a Canadian study of 3,341 persons found that midwives were more likely to provide nutrition and weight management advice to clients than were other prenatal health care providers. Yet Murray-Davis et al., did not find associations between health care providers and pregnancy weight gain in a cohort of 231,697

pregnant individuals in Ontario.[1,32] Our study supports the view that pregnant individuals who seek out a midwife for prenatal care have higher socioeconomic status, have better mental health, are more likely to have a normal weight pre-pregnancy body mass index, and are less likely to engage in substance use during pregnancy. Taking these characteristics into consideration, midwife care is associated with decreased odds of low birth weight but increased odds for macrosomic babies. Future research should focus on the mechanisms behind these differences in birth outcomes and the reasons for self-selection into midwifery care in Canada.

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