

A Study of the Association of Maternal Occupations and Deliveries by Cesarean

Section for Infants born in Washington, 2011-2013

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DISCLOSURE

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Abstract

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Nearly one-third of all pregnancies in the United States are surgically delivered by cesarean, which has a higher rate of maternal complications compared to vaginal delivery. There are national campaigns to reduce the number of cesarean sections in low-risk pregnancies, which are defined as nulliparous, vertex, singleton, and term (NVST). The objective for this study was to determine the effect of

maternal occupations and risk of cesarean delivery in low risk pregnancies. A population-based, retrospective cohort study was conducted using Washington State birth certificate records for the years 2011 through 2013. This study analyzes the association between maternal exposure of non-agricultural occupations (n = 1259) and the outcome of cesarean delivery compared with maternal agricultural occupations (n = 193) and cesarean delivery for low-risk pregnancies. Logistic regression revealed that women working in non-agricultural occupations had a 1.33 (95% confidence interval (CI): 0.87-2.01) higher odds for cesarean delivery than women working in agricultural occupations in Washington from 2011-2013 (p = 0.18). Although no significant association was found between maternal occupations and cesarean delivery, future studies should investigate other potential associations to include advanced maternal age and cesarean delivery as well as prenatal insurance and cesarean delivery.

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CHAPTER 1

INTRODUCTION

In the United States, nearly one-third of all infants are delivered by cesarean section.¹ According to a National Vital Statistics Report, cesarean deliveries for all pregnancies increased by 60% from 1996 to 2009 and since 2009 has slightly decreased by approximately 1% in the U.S.¹ According to Barber *et al.*, primary cesarean rate has increased because of non-reassuring fetal status, labor arrest disorders, multiple gestation, suspected macrosomia, pre-eclampsia, maternal request, maternal fetal conditions, and other obstetric conditions.²

This increasing trend has been similar for low-risk pregnancies, which is defined as nulliparous (without prior birth) women who are term (37 or more weeks gestation) with a single fetus who is in the vertex position (head down) just prior to birth.¹ The national percentage of these low-risk pregnancies delivered via cesarean section was 18.4% in 1997 rising to a peak of 28.1% in 2009, which was followed by a gradual decline to 26.9% in 2013.¹ According to a Consumer Reports investigation, the risk of cesarean for low risk pregnancies varies between hospitals and varies between states.³

Due to the increases in cesarean sections in low-risk pregnancies, some of the new objectives established by both the Joint Commission's National Quality Core

Measures and by the U.S. Department of Health and Human Services' Healthy People 2020 campaign have focused on reducing deliveries by cesarean section in low-risk pregnancies.^{4,5} It has been observed that since the implementation of these campaigns, Washington State has experienced a 3% decline in primary cesarean deliveries among singleton births from 2009 to 2012.⁶

In a 2014 news release, the American Public Health Association announced that areas in the U.S. with fewer obstetricians favor lower rates of cesarean deliveries, and U.S. counties with more hospital beds per county resident tend to have more deliveries by cesarean.⁷ Recent publications on reducing low-risk pregnancy cesarean deliveries have focused on insurance type and ethnicity, and have shown mixed results.^{8,9}

One such study published in 2014 by Henke *et al.* found that Black, Asian, and Native Americans were more likely to undergo cesarean if they held private insurance compared to women who are White and held private insurance.⁸ The results of this study were significant in some U.S. counties.⁸ Henke *et al.* found that four Washington counties had a significant association in the rate of cesarean sections when adjusting for maternal payment method.⁸

A study published in February 2016 by Morris *et al.* showed that non-reassuring fetal heart rate in nulliparous, term, singleton (one fetus), and vertex

(NTSV) pregnancies had a 45% probability of cesarean delivery when the maternal payment method was Medicaid or no insurance and a 25% probability of cesarean delivery with private insurance.⁹ The same study found that cephalo-pelvic disproportion in NTSV pregnancies have a 20% probability of cesarean section in White women and 9% in Black women compared to Hispanic women. This study found that all women had a 20% increased probability of undergoing a cesarean section on the weekend compared to an 8% probability during the week.⁹

An earlier study published in 2005 by Simoes *et al.* sought to determine the influence of education attainment and maternal occupations on surgical deliveries by cesarean.¹⁰ Of note, all the women in the study had universal health coverage, and Simoes *et al.* used data from a post-natal survey collected in Baden-Württemberg, Germany.¹⁰ In this study, they defined six occupational categories as housewives, trainees/students, skilled workers and officers, unskilled workers, high salaried positions, and unknown.¹⁰ By defining high salary as women working as physicians, attorneys, managers, or other leading positions as well as defining unskilled maternal occupations as women working as janitorial or housekeeping types of occupations, Simoes *et al.* showed a significant association between cesarean delivery and women working in both high salary and unskilled occupations.¹⁰

A possible mechanism in reducing surgical deliveries in low risk pregnancies could focus on maternal preferences including time to recovery and need to return to

work. To better understand the influence on physically demanding occupations and cesarean, this study will determine if a positive association exists between maternal occupations in non-agricultural occupations and cesarean section compared to women working in the agricultural sector.

CHAPTER 2

METHODS

This study was conducted as a population-based, retrospective cohort examining the association between maternal occupations as an exposure and cesarean deliveries as an outcome with de-identified data from Washington State birth certificates linked with hospital records. The specific aim and hypothesis are as follows:

Aim: to determine if an association exists between deliveries via cesarean section in low-risk pregnancies and mothers who reported occupations in the agricultural sectors listed on the birth certificate in Washington State

Hypothesis: A positive association will be seen between cesarean sections in low-risk pregnancies for mothers who reported non-agricultural occupations as compared to mothers who reported working in agricultural occupations.

The data in this study was derived from birth certificate data collected and maintained by the Washington State Department of Health. The data linked infant birth certificates with Comprehensive Hospital Abstract Report System (CHARS) data, which included maternal and infant inpatient hospital discharge information in Washington during the years of 2011-2013.

Inclusion criteria were employed women who had low-risk pregnancies and who were 18 years-of-age or older at the time of delivery. For this study, low-risk pregnancies was defined as NTSV pregnancies without known medical conditions associated with increased risk of cesarean deliveries. According to the National Library of Medicine, the March of Dimes, and the American College of Obstetricians and Gynecologists, clinical guidelines for medical determined reasons for cesarean delivery include the following¹¹⁻¹³:

umbilical cord prolapse, fetal distress, birth defects (spina bifida, gastroschisis, omphalocele, and hydrocephalus), polyhydramnios, placenta abruption, placenta previa, uterine rupture, forceps failure, cephalo-pelvic disproportion, fetal shoulder dystocia, prolonged labor, and maternal medical conditions including genital herpes infection, diabetes, chronic hypertension, pre-eclampsia, eclampsia, prior uterine surgeries, fibroids, HIV status, HPV status, history of cervical cancer, certain heart conditions.

The exposed cohort consisted of women working in non-agricultural occupations, and the non-exposed cohort comprised of women working in agricultural occupations. Occupations in agriculture consisted of the following Samuel Milham codes:¹⁴

Farmers, Owners, and Tenants (200), Orchardists (201), Nursery Workers (202), Ranchers (203), Dairy Farmers (204), Wheat and Grain Farmers (205), Egg and Poultry Farmers, Distributors (206), Farm Managers (222), Farm Foremen (901), Farm Laborers, Wage Workers (902), Unpaid Family Farm Workers (903), Farm Caretakers (904), Self-Employed Farm Service (905), Itinerant Laborers (906), and Orchard Laborers, Brush Pickers (983).

The non-agricultural occupations consisted of all occupations excluding agricultural occupations and the following categories: stay-at-home (908), “child

under 18” (996), “inmates/disabled” (997), “unemployed” (998), or “not stated / unknown” (999).^{9,10} This study focused on mothers who are 18 years-of-age and older, and by eliminating the variable “child under 18,” there was no effect on misclassification in regards to this variable.¹⁵

Possible confounders and effect modifiers include advanced maternal age and socioeconomic status (SES) factors including ethnicity, marital status, education, and insurance coverage. Covariates were adjusted for when the odds ratio was meaningfully different from the crude (greater than 10%). The following covariate were organized into nominal variables with 3 to 4 categories: ethnicity (White, Black, Hispanic, other), education (less than high school, high school graduate/ equivalent, some college, college degree to include bachelor, master, or PhD), and perinatal insurance (private, Medicaid, self-pay, other). Advanced maternal age and marital status were organized into dichotomous variables (yes, no).

To evaluate the association of maternal occupations and infant delivery via cesarean section, logistic regression was utilized in STATA 14®, and four models were constructed. Model 1 measured the crude association between maternal occupations and cesarean delivery. Model 2 calculated the association between maternal occupations and cesarean delivery and adjusted for maternal age. Model 3 calculated the influence of socioeconomic status (SES) factors including ethnicity,

marital status, education, and insurance coverage in the association between maternal occupations and surgical delivery. Model 4 measured the influences of both maternal age and SES variables in the association between maternal occupations and cesarean delivery. The odds ratios with a confidence interval (CI) of 95% were given.

CHAPTER 3

RESULTS

Maternal characteristics of women who were age 18 years and older with low-risk pregnancies and working in non-agricultural and agricultural occupations were compared (Table 1). The distribution of maternal age was similar between women working in non-agricultural and agricultural occupations (5.6% to 4.7% for women who were advanced maternal age—35 or older). In comparing the distribution of other selected characteristics in Table 1, women employed in non-agricultural occupations were in general more likely to have higher education attainment (55.4% to 31.1% for some college and 9.6% to 3.1% for a college degree), more likely to be ethnically White (82.5% to 57.5%), more likely to be married (61.6% to 42.5%) and to have private insurance (50.0% to 26.4%) as compared to women employed in agriculture. There were some other notable differences in the distribution of selected characteristics as listed in Table 1. Thirty point one percent of women employed in agriculture had less than a high school education compared to 8.5% of women working in a non-agriculture occupations. Women working in agriculture were more likely to be Hispanic (35.2% to 7.2%) and were more likely to have Medicaid (68.9% to 35.1%) compared to women working in non-agricultural occupations.

Table 1. Selected characteristics of mothers ages 18 years or older at the time of delivery with low risk pregnancies and reported non-agricultural versus agricultural occupations in Washington, 2011-2013.

Maternal Characteristics	Maternal Occupations			
	Non-Agricultural N=1259		Agricultural N=193	
	n	%	n	%
Age (years)				
18-34	1188	94.4	184	95.3
35+	71	5.6	9	4.7
Education				
Less than High School	107	8.5	58	30.1
High School	333	26.4	69	35.8
Some College	698	55.4	60	31.1
College Degree (Bachelor, Master, PhD)	121	9.6	6	3.1
Ethnicity ^a				
White	1039	82.5	111	57.5
Black	29	2.3	2	1.0
Hispanic	91	7.2	68	35.2
Other	93	7.4	2	1.0
Marital Status ^b				
Married	776	61.6	82	42.5
Single	480	38.1	111	57.5
Prenatal Insurance ^c				
Self Pay	20	1.6	2	1.0
Private Insurance	630	50.0	51	26.4
Medicaid	442	35.1	133	68.9
Other	154	12.2	5	2.6

^a Missing data 0.1% (non-agriculture), 5.2% (agriculture).

^b Missing data 0.2% (non-agriculture).

^c Missing data 0.1% (non-agriculture), 0.1% (agriculture).

Table 2 reports the results of the association between maternal occupations and cesarean delivery. Model 1 measured the crude association between non-agricultural occupations and surgical delivery by cesarean. The odds of cesarean delivery is 1.33 times higher (95% CI: 0.88-2.01) in women working in non-agricultural occupations compared to women working in agricultural occupations. However, this finding was not significant ($p = 0.18$).

Model 2 added advanced maternal age to the crude model. However, no significant association was found between maternal occupations and cesarean delivery. After adjusting for non-agricultural occupations, the odds of cesarean delivery for women who were advanced maternal age (35 years or older at the time of delivery) is 2.57 times higher (95% CI: 1.59-4.13) than women ages 18 to 34 at the time of delivery, and this finding was significant ($p < 0.01$).

Model 3 added SES variables to the crude model on the association between occupations and cesarean. SES variables included education, ethnicity, marital status, and insurance. After adjusting for nonagricultural occupations and SES variables, the odds of cesarean delivery for women with prenatal insurance is 0.80 (95% CI: 0.66-0.98) compared to women who were self-pay, and this finding was significant ($p = 0.03$). Prenatal insurance included private, Medicaid, and other types of insurance.

Model 4 was the full model, which includes occupations, advanced maternal age, and SES variables. The model showed that women who were advanced maternal age have a 2.39 (95% CI: 1.46-3.91) higher odds of surgical delivery than women who were 18 to 34 years-of-age at the time of delivery after adjusting for non-agricultural occupations and SES variables, which included education, ethnicity, marital status, and insurance. This association was significant ($p < 0.01$).

Table 2. Crude and adjusted odds ratios (OR) for cesarean deliveries associated with maternal occupations (non-agricultural versus agricultural) in Washington, 2011-2013.

	Model 1: Crude	Model 2: Maternal Age	Model 3: SES ^a	Model 4: Maternal Age + SES
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Non-Agricultural	1.33 (0.88-2.01)	1.31 (0.87-1.99)	1.18 (0.77-1.80)	1.18 (0.77-1.80)
Advanced Maternal Age ^b		2.57 (1.59-4.13)		2.39 (1.46-3.91)
SES				
Education			1.07 (0.93-1.24)	1.10 (0.95-1.26)
Ethnicity			1.11 (0.97-1.28)	1.11 (0.97-1.28)
Marital Status			0.87 (0.66-1.13)	0.89 (0.69-1.14)
Prenatal Insurance			0.80 (0.66-0.98) ^c	0.83 (0.68-1.02)

^a Socioeconomic status (SES) = maternal education + ethnicity + marital status + prenatal insurance

^b $p < 0.01$

^c $p = 0.03$

CHAPTER 4

DISCUSSION

This study showed no significant association between women with low-risk pregnancies working in non-agricultural occupations and cesarean section deliveries compared to women working in agricultural occupations in Washington during the years of 2011-2013. Significant associations were found between advanced maternal age and cesarean when adjusting for non-agricultural occupations and when adding certain identified SES factors including education, ethnicity, marital status, and prenatal insurance to the model. A significant association was also found between mothers with prenatal insurance and cesarean deliveries when adjusting for non-agricultural occupations.

It was not surprising that significant associations were found between advanced maternal age and risk of cesarean deliveries as well as prenatal insurance and risk of cesarean deliveries. Bayrampour and Heaman completed a systematic review on the association of advanced maternal age and increased risk of cesarean deliveries, and they found a relative risk of 1.39 for nulliparous women.¹⁶ Studies analyzing the association between cesarean deliveries and prenatal insurance have found various results.⁸ As discussed in the Introduction, Henke *et al.* found differences in risk of cesarean for minority women who held private insurance

compared to White women who held private insurance, and the results had a geospatial relationship to U.S. counties.⁸ Morris *et al.* found women who had NTSV pregnancies and experienced non-reassuring fetal heart rate at delivery had a 45% probability of cesarean delivery when the maternal payment method was Medicaid or no insurance and a 25% probability of cesarean delivery with private insurance.⁹

There were some potential covariates that cannot be controlled for because the information was not provided in the dataset. Previous studies have found that a positive association between risk of cesarean and birth day of week, maternal factors of prior uterine surgeries, fibroids, HIV status, HPV status, history of cervical cancer, heart conditions as well as a fetal factor of shoulder dystocia.^{9,11-13} Due to IRB restrictions on data use for this dataset, zip code information was not included.¹⁵ Geospatial relationships could not be controlled for in this study, and prior studies have shown the importance of geospatial relationships in determining the risk of cesarean sections.^{7,8} The American Public Health Association reported that access to an obstetricians and number of bed to county resident were associated with the risk of cesarean delivery.⁷ Henke *et al.*, found that when adjusting for maternal payment method the risk of cesarean delivery was significant depending on the U.S. county.⁸

The available data presented in this study had some limitations. Inevitably, there was a degree of non-differential misclassification of the self-reported exposure

(maternal occupation). It was not possible to determine how long mothers worked in the occupation, if she continued working during her pregnancy, or if she returned to work after her pregnancy from the birth certificate data.

There were two significant associations found in this study—the association between advanced maternal age and cesarean deliveries as well as the association between prenatal insurance and cesarean deliveries. However, these associations were not the aim of this study, and as such, these associations should be the focus of future hypotheses and studies. Future studies could also consider selecting occupations with similar demographics to avoid misinterpreting the results.

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