



The Impact of Sickle Cell Status on Adverse Delivery Outcomes Using Electronic Health Record Data

S17: Applied Clinical Research Informatics

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*I have no relevant relationships
with commercial interests to disclose*

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Learning objectives

Understand how electronic health record (**EHR**) data was leveraged to study the impact of **sickle cell disease** on adverse:

- delivery outcomes including **stillbirth**
- hematological outcomes like **blood transfusion** and **hemorrhage** during delivery.

Motivation

- Pregnant people are often underrepresented in clinical research, as are ethnic and racial minorities
- Those pregnant with sickle cell have been shown to be at an increased risk of adverse outcomes [1]
- The granularity of our dataset enables the study of pregnancy-specific contributions to the risk of a clinical complication at the time of delivery
- We estimate a higher incidence of sickle cell trait at Penn Medicine (~9.8%) compared to national estimates (~7.7%) [2]

1. Barfield WD, Barradas DT, Manning SE, et al. Am J Prev Med. 2010;38:S542–9

2. Centers for Disease Control and Prevention. Data & Statistics on Sickle Cell Disease. 2017

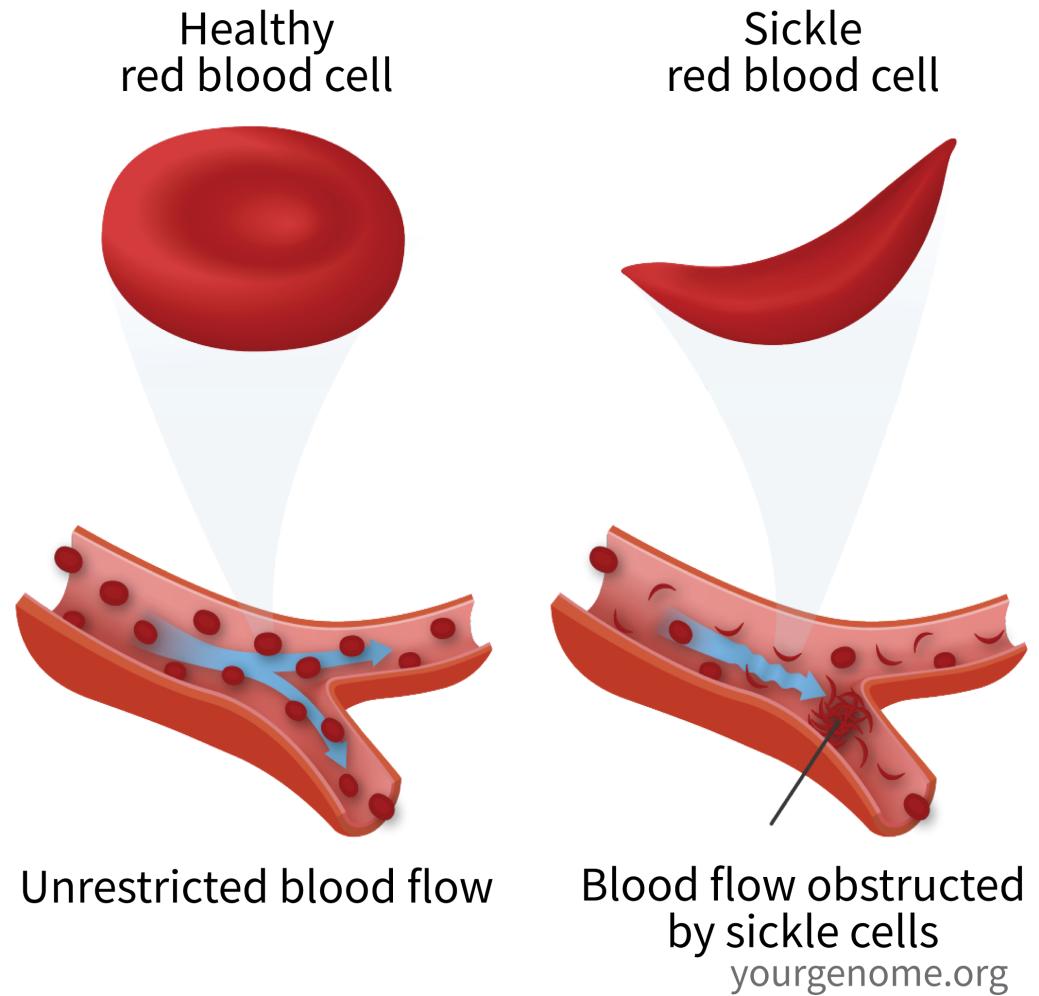
Analysis

1. Used our MADDIE algorithm [1] to identify **63,334 distinct deliveries** from EHR of **1,060,000 female patients** with visits to Penn Medicine between **2010-2017**
2. Identified **delivery and hematological outcomes of interest** occurring within the patients' delivery episode(s)
3. Constructed **generalized logistic regression model** to assess the risk of a variety of predictors on delivery and hematological outcomes

1. [Canelón et al. Int J Med Inform \(2020\)](#)

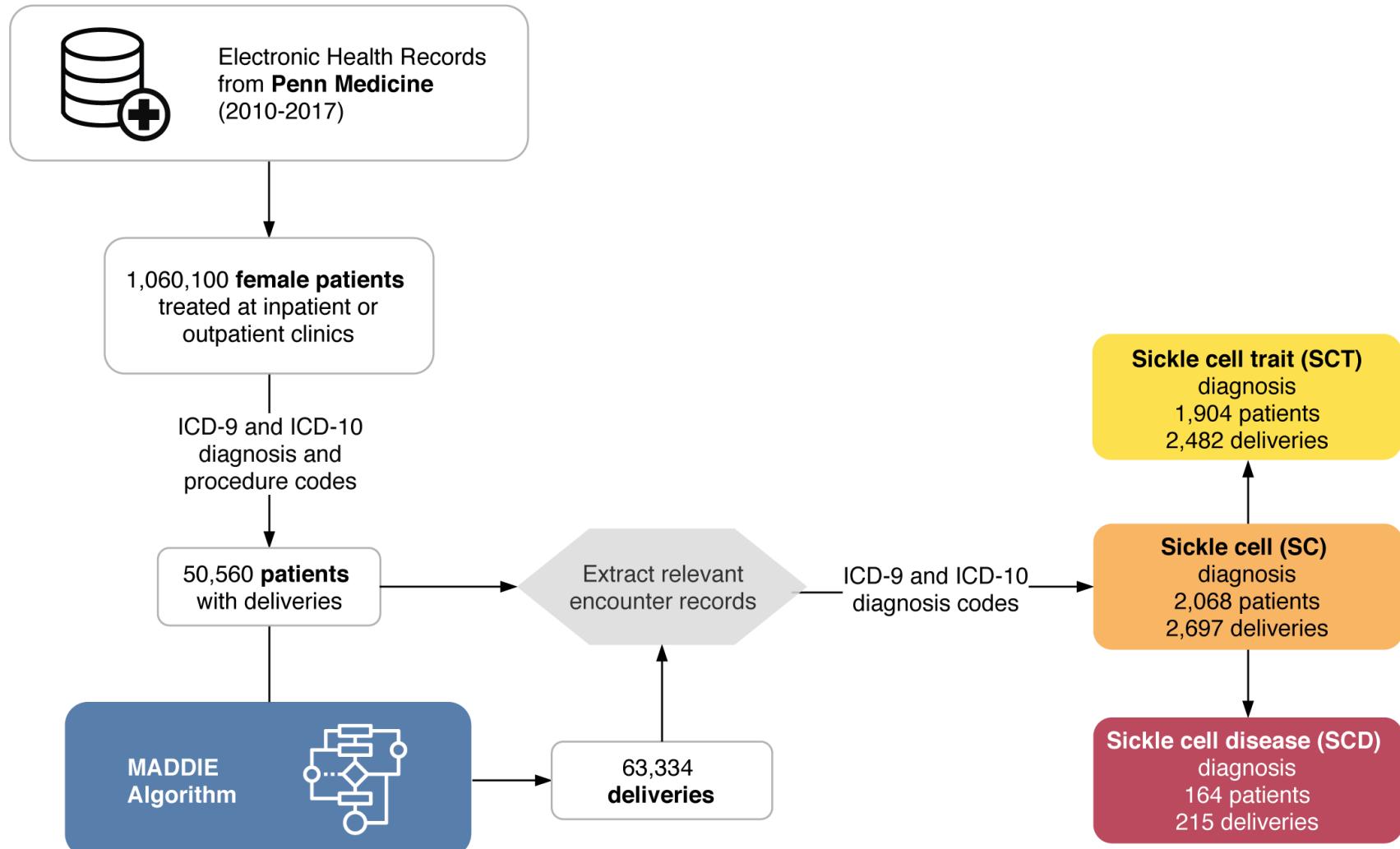
Sickle cell disease

- Complex inherited genetic disorder and most common hemoglobinopathy in the U.S., affecting ~100,000 people [1]
- Inheriting one hemoglobin S gene results in **sickle cell trait**; inheriting two abnormal genes results in **sickle cell disease**
- The disease is characterized by abnormal hemoglobin and "sickle" red blood cells
- Primarily affects individuals of African ancestry and is associated with high lifetime morbidity and premature mortality [2]

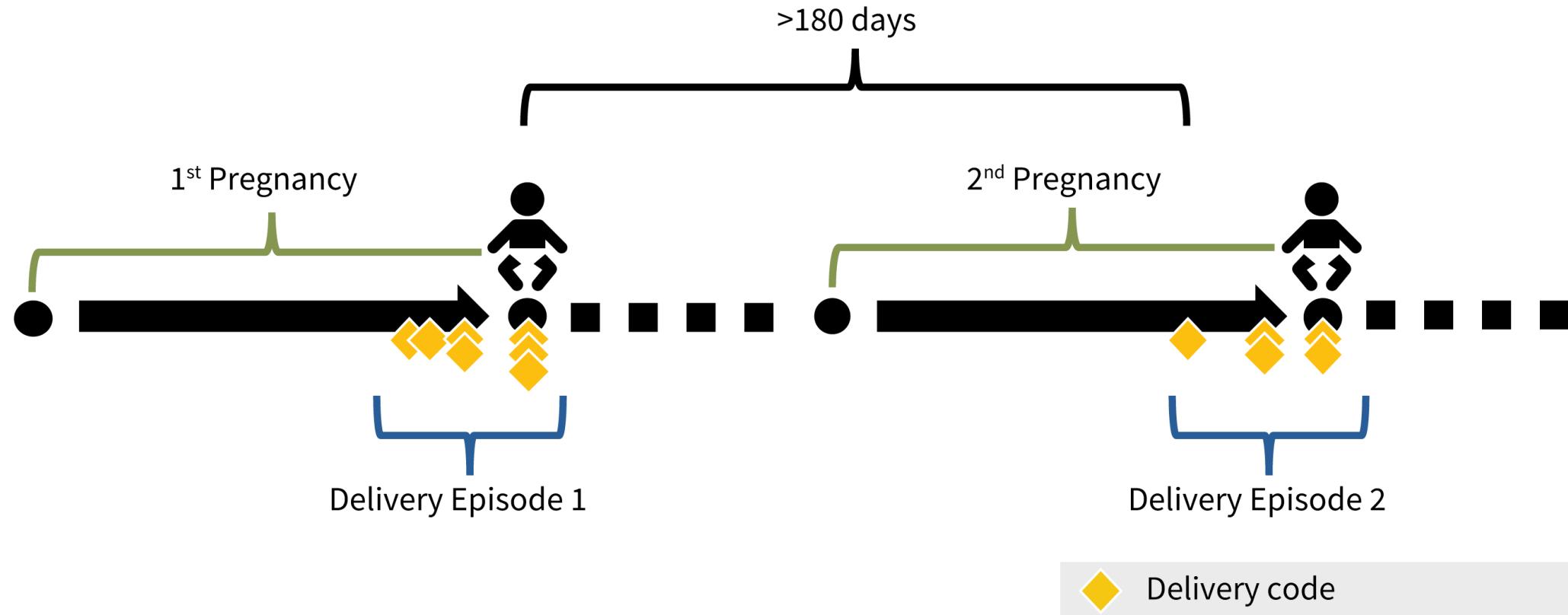


1. Centers for Disease Control and Prevention. Data & Statistics on Sickle Cell Disease. 2017
2. Kuo K, Caughey AB. Am J Obstet Gynecol. 2016;215(4)

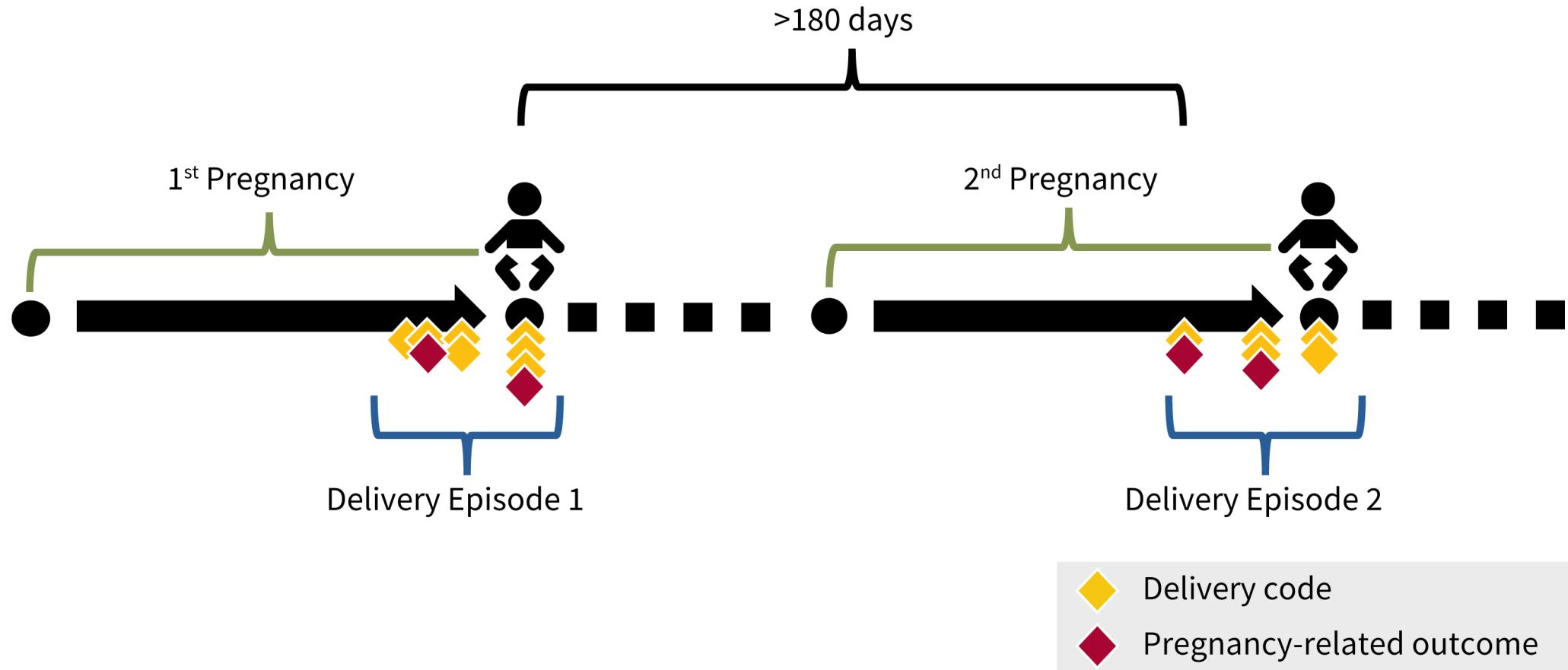
Study overview



Identifying delivery episodes with the MADDIE algorithm



Identifying outcomes within delivery episodes



Patient population at Penn Medicine

	Patients (%)	Deliveries (%)
All Patients	50560 (100.0)	63334 (100.0)
No Sickle Cell	48492 (95.9)	60637 (95.7)
Sickle Cell Mutation	2068 (4.1)	2697 (4.3)
Sickle Cell Trait	1904 (3.8)	2482 (3.9)
Sickle Cell Disease	164 (0.3)	215 (0.3)

Race/Ethnicity	Patients (%)	Deliveries (%)
Sickle Cell Mutation		
All Patients	2068 (100.0)	2697 (100.0)
Hispanic	53 (2.6)	62 (2.3)
Black/African American	1921 (92.9)	2518 (93.4)
Asian	11 (0.5)	14 (0.5)
Other or Mixed	31 (1.5)	40 (1.5)
Unknown	21 (1.0)	22 (0.8)
White	38 (1.8)	49 (1.8)

All race/ethnicity descriptions are 'Non-Hispanic' unless otherwise indicated

Logistic regression model

Delivery outcomes

- C-Section
- Preterm birth
- Stillbirth

Hematological outcomes

- Blood transfusion
- Hemorrhage
- Pain crisis

Predictors

- Sickle cell status (SCT, SCD)
- No. of pain crisis before delivery
- No. of blood transfusions before delivery
- Delivery episode
- Prior C-section
- Multiple birth diagnosis
- Patient age
- Marital status
- Race/ethnicity
- Blood type and blood factor Rh
- Year

Logistic regression model

Delivery outcomes

- C-Section
- Preterm birth
- **Stillbirth**

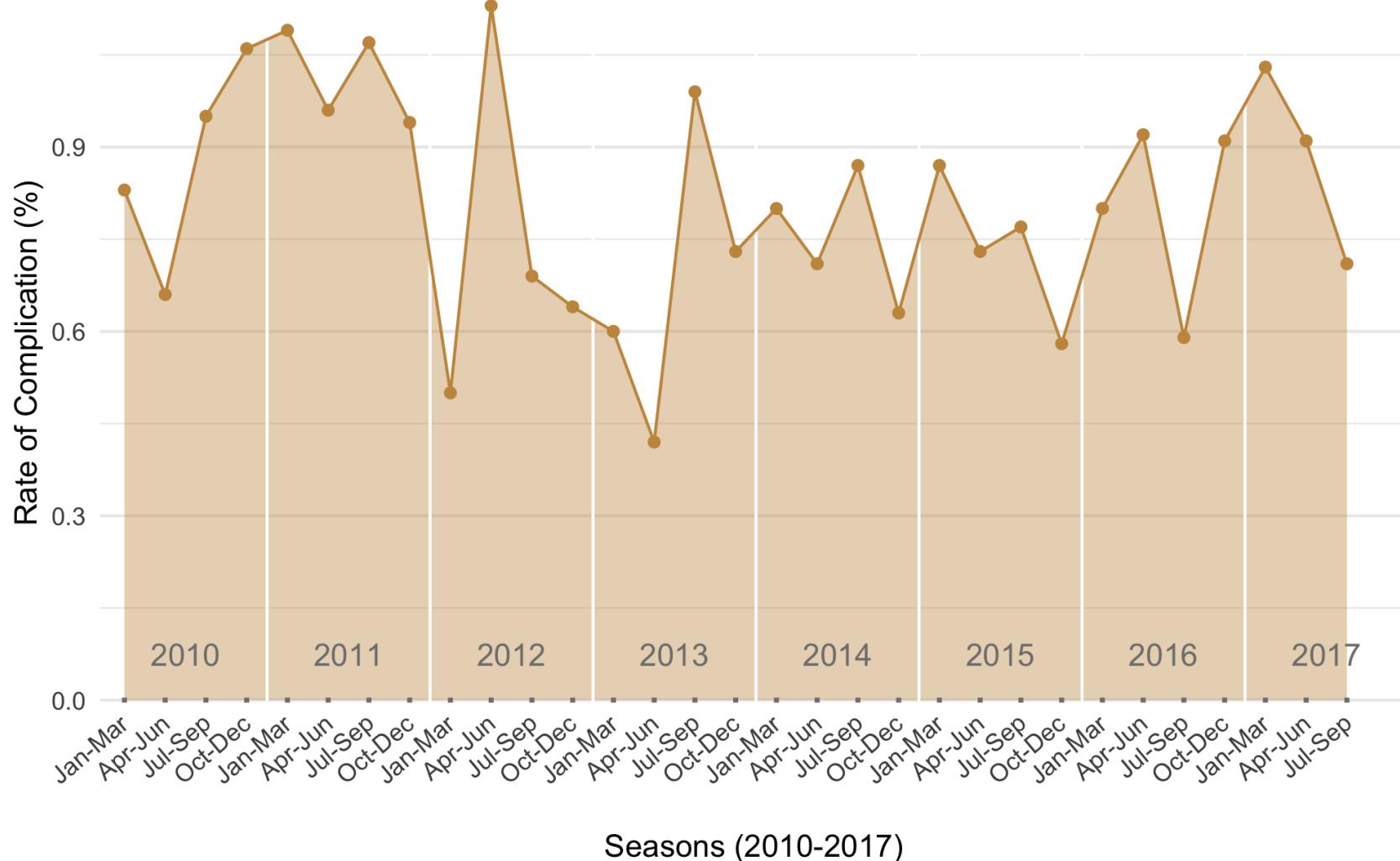
Hematological outcomes

- **Blood transfusion**
- **Hemorrhage**
- Pain crisis

Predictors

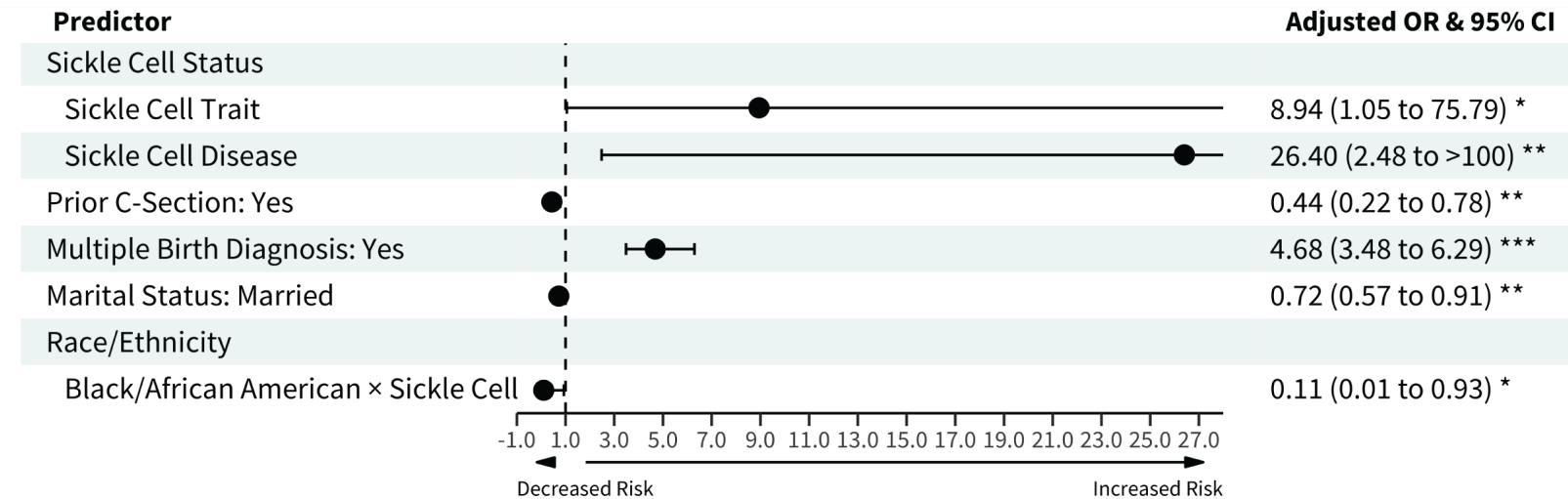
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- No. of pain crisis before delivery
- No. of blood transfusions before delivery
- Delivery episode
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Stillbirth: Rates over time

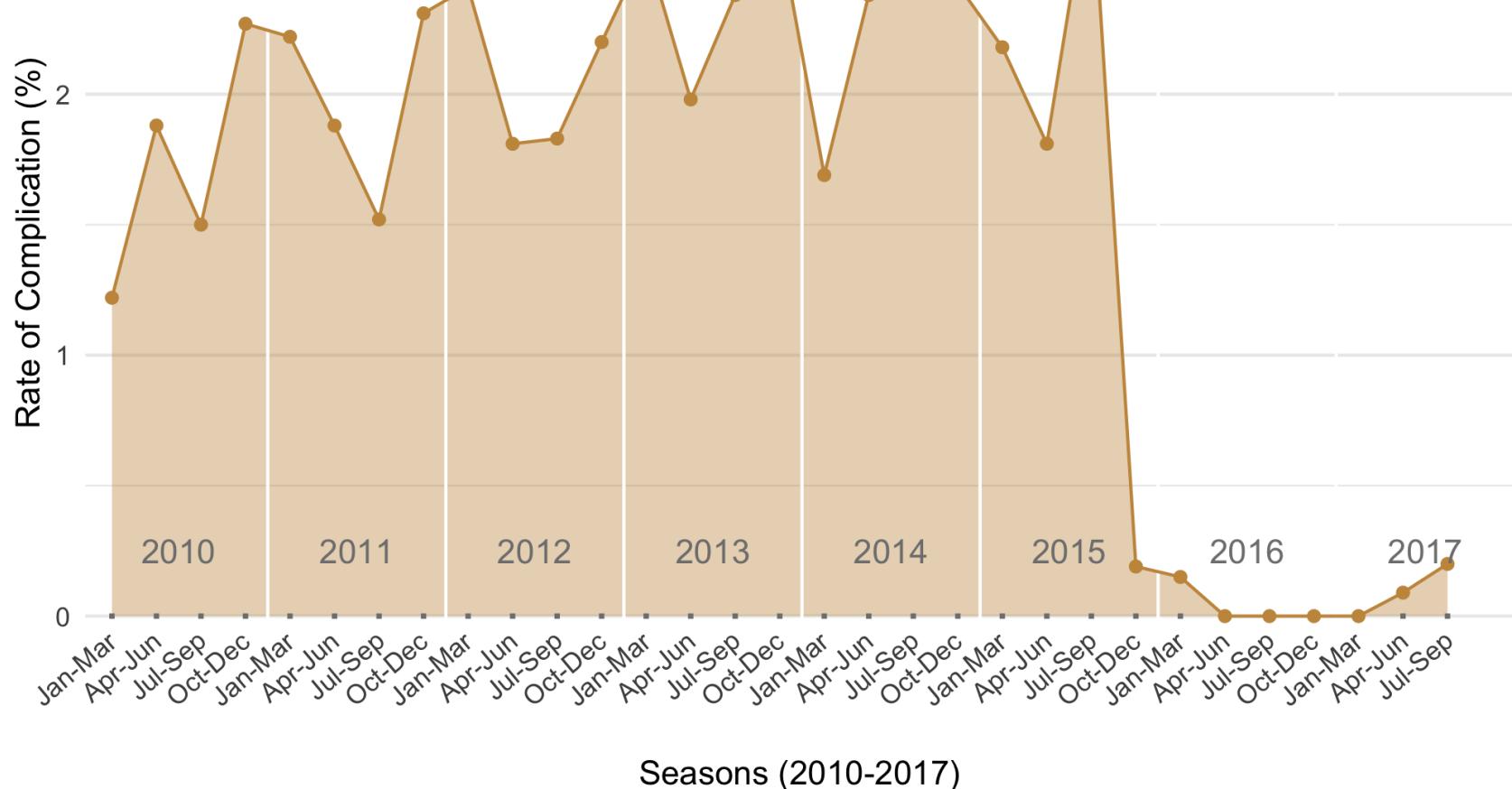


Stillbirth: Model results

Stillbirth: Adjusted odds ratio estimates with 95% confidence intervals

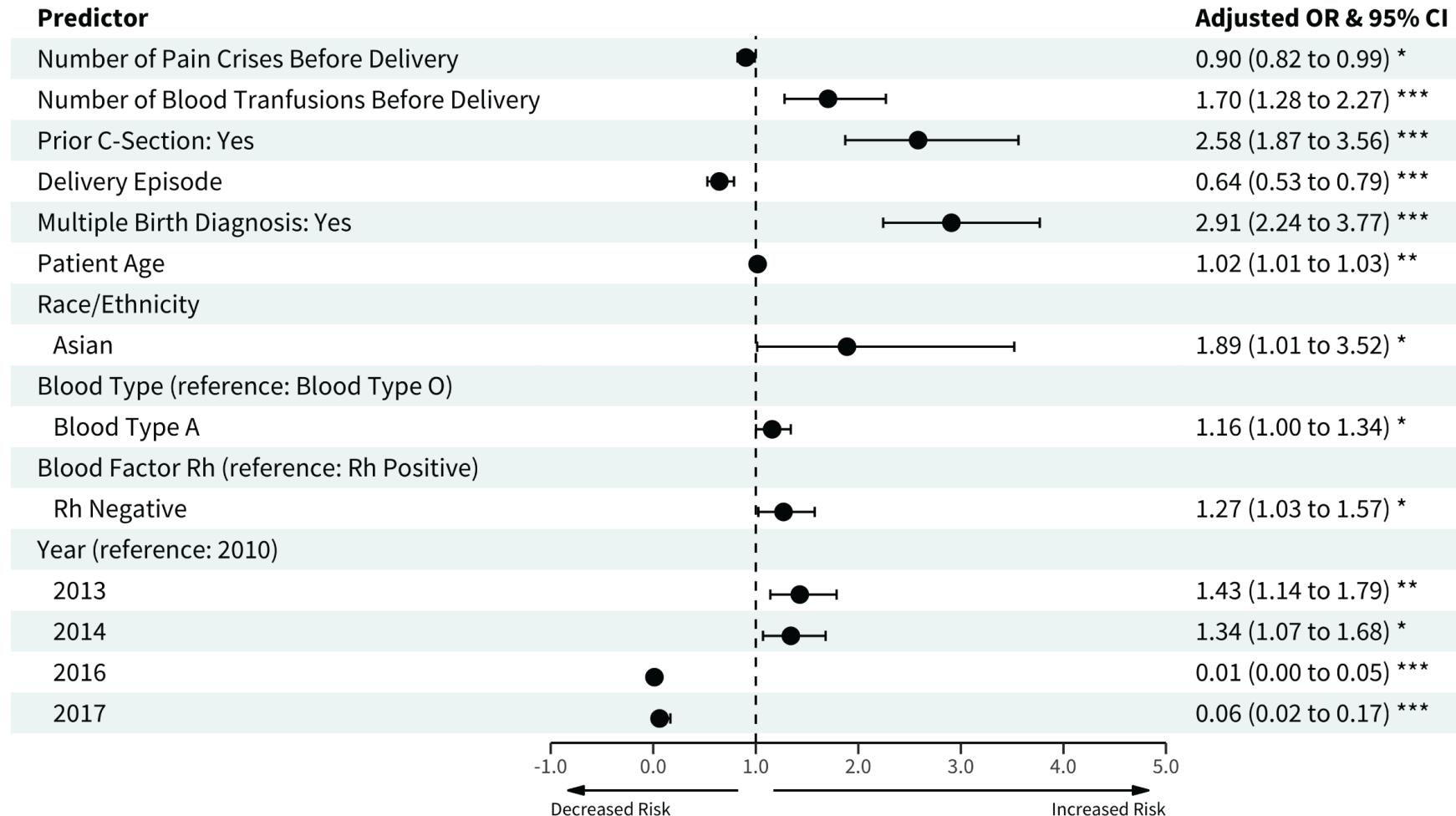


Blood transfusion: Rates over time

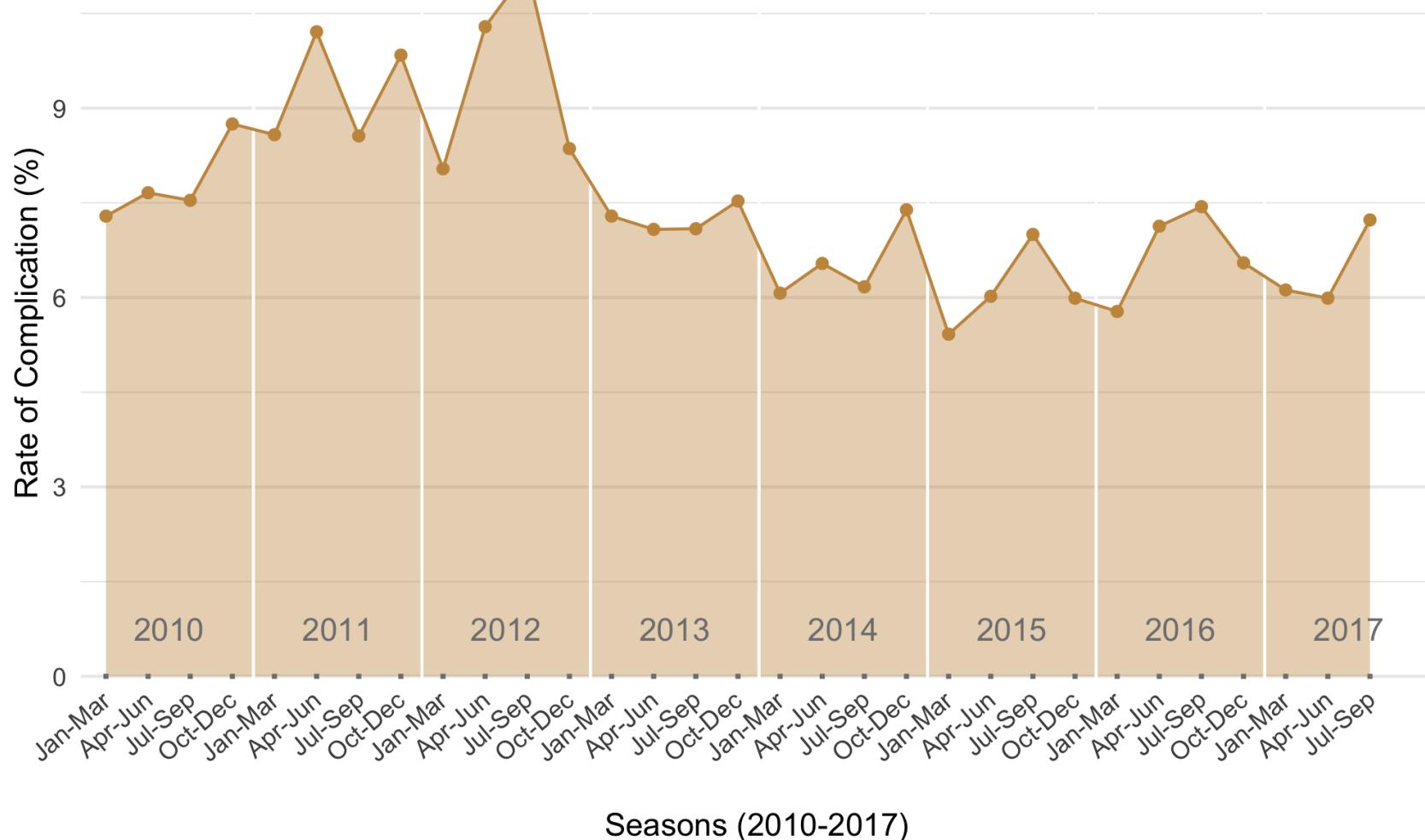


Blood transfusion: Model results

Blood Transfusion: Adjusted odds ratio estimates with 95% confidence intervals

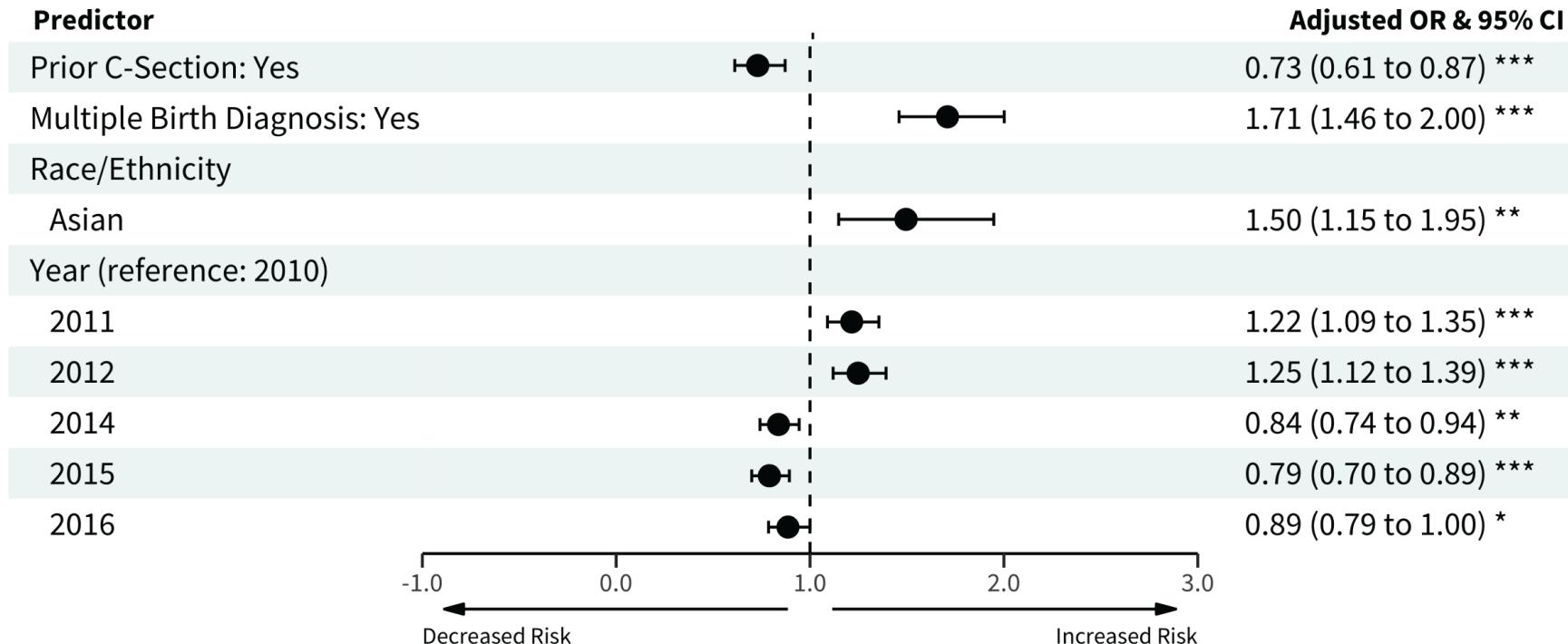


Hemorrhage: Rates over time



Hemorrhage: Model results

Hemorrhage: Adjusted odds ratio estimates with 95% confidence intervals



*p-value < 0.05, **p-value < 0.01, ***p-value < 0.001

Limitations

- Billing codes (e.g. ICD-9/10) are imperfect at capturing clinical conditions
- The study did not include data on hemoglobin variants which would help
 - Confirm sickle cell status
 - Identify additional patients with homozygous sickle cell disease
 - Identify heterozygous patients that are asymptomatic
- Blood transfusion capture after the transition to ICD-10 was limited by a change in coding practices [1]

1. [AIM Severe Maternal Morbidity \(SMM\) Data Alert for Blood Transfusions. 2016](#)

Conclusions

- Patients with sickle cell disease were not found to be at increased risk of *all* adverse delivery outcomes, including hemorrhage, a severe maternal morbidity.
- Pregnancies of patients with sickle cell were at increased risk of blood transfusions and stillbirth.
- These results underscore the need for systemic support for comprehensive coordinated care for sickle cell patients, particularly during pregnancy and delivery

Publication

You'll be able to view the full results and read more about the study in our upcoming preprint.

🔗 Stay tuned for updates on the webpage for this talk:
The Impact of Sickle Cell Status on Adverse Delivery Outcomes Using Electronic Health Record Data



Thank you!

 silvia.rbind.io

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This presentation was made using the
AMIA template and the following R packages:
[xaringan](#), [xaringanExtra](#), [kableExtra](#), and [forester](#).

Tables of significant model results

Stillbirth	Blood transfusion	Hemorrhage
Predictor	Adjusted OR & 95% CI	
Sickle Cell Status		
Sickle Cell Trait		8.94 (1.05 to 75.79) *
Sickle Cell Disease		26.40 (2.48 to >100) **
Prior C-Section: Yes		0.44 (0.22 to 0.78) **
Multiple Birth Diagnosis: Yes		4.68 (3.48 to 6.29) ***
Marital Status: Married		0.72 (0.57 to 0.91) **
Race/Ethnicity		
Black/African American × Sickle Cell	0.11 (0.01 to 0.93) *	

* pvalue < 0.05, ** p-value < 0.01, *** p-value < 0.001

Tables of significant model results

Stillbirth	Blood transfusion	Hemorrhage
	Predictor	Adjusted OR & 95% CI
	Number of Pain Crises Before Delivery	0.90 (0.82 to 0.99) *
	Number of Blood Tranfusions Before Delivery	1.70 (1.28 to 2.27) ***
	Prior C-Section: Yes	2.58 (1.87 to 3.56) ***
	Delivery Episode	0.64 (0.53 to 0.79) ***
	Multiple Birth Diagnosis: Yes	2.91 (2.24 to 3.77) ***
	Patient Age	1.02 (1.01 to 1.03) **
	Race/Ethnicity	
	Asian	1.89 (1.01 to 3.52) *
	Blood Type (reference: Blood Type O)	
	Blood Type A	1.16 (1.00 to 1.34) *
	Blood Factor Rh (reference: Rh Positive)	
	Rh Negative	1.27 (1.03 to 1.57) *
	Year (reference: 2010)	
	2013	1.43 (1.14 to 1.79) **
	2014	1.34 (1.07 to 1.68) *
	2016	0.01 (0.00 to 0.05) ***
	2017	0.06 (0.02 to 0.17) ***

* pvalue < 0.05, ** p-value < 0.01, *** p-value < 0.001

Tables of significant model results

Stillbirth	Blood transfusion	Hemorrhage
		Predictor
		Adjusted OR & 95% CI
	Prior C-Section: Yes	0.73 (0.61 to 0.87) ***
	Multiple Birth Diagnosis: Yes	1.71 (1.46 to 2.00) ***
	Race/Ethnicity	
	Asian	1.50 (1.15 to 1.95) **
	Year (reference: 2010)	
	2011	1.22 (1.09 to 1.35) ***
	2012	1.25 (1.12 to 1.39) ***
	2014	0.84 (0.74 to 0.94) **
	2015	0.79 (0.70 to 0.89) ***
	2016	0.89 (0.79 to 1.00) *

* pvalue < 0.05, ** p-value < 0.01, *** p-value < 0.001