**Risk Factors for Maternal Group B Streptococcus Colonization: A Population-Based Case-Control Study in Washington State 2003-2014**

Ronit Abramson, Naomi Schwartz, Diana Tordoff

Preceptor: Rachel Winer

**Background:** Maternal colonization with Group B streptococcus (GBS) occurs in 10 to 30% of pregnant women and is the leading infectious cause of mortality in newborns in the United States. This is the first population-based study of multiple risk factors for GBS since the implementation of universal screening guidelines, which recommend screening for all pregnant women between 35-37 weeks gestation.

**Methods:** We conducted a population-based case-control study to evaluate risk factors for GBS colonization. Washington State birth certificate data (2003-2014) were linked to hospital discharge data obtained from the Washington State Comprehensive Hospital Abstract Reporting System to identify 16,148 cases with GBS colonization and 64,121 controls, frequency matched by year of delivery. We excluded pre-term births and women who received no prenatal care. We identified potential risk factors (race, obesity, pre-eclampsia, genital herpes, bacterial sexually transmitted infections (STIs), and diabetes) and evaluated if obesity modified the association between those risk factors and GBS.

**Results:** Compared to White women, Black (OR:1.47, 95%CI:1.35-1.58) and Native Hawaiian/Pacific Islander (OR:1.23, 95%CI:1.10-1.38) women were at increased risk while Asian (OR:0.92, 95%CI:0.86-0.98), Hispanic (OR:0.70, 95%CI:0.66-0.75), and Native American (OR:0.86, 95%CI:0.76-0.97) women were at decreased risk. Compared to women with normal BMI, obese (OR:1.17, 95%CI:1.12-1.23) and severely obese women (OR:1.39, 95%CI:1.28-1.51) were at increased risk. Established diabetes (OR:1.34, 95%CI:1.08-1.66), genital herpes (OR:1.26, 95%CI:1.15-1.38), and bacterial STI (OR:1.25, 95%CI:1.08-1.45) also increased risk. Obesity did not modify any observed associations.

**Conclusions:** We identified several demographic and health factors associated with increased risk for GBS.Knowledge of these potential risk factors for may help identify women at greatest risk of giving birth to babies with GBS infections and inform an eventual targeted vaccine or alternative therapeutic for high-risk pregnancies to protect mothers and infants.

**Pre-Pregnancy Body Mass Index and Success of Returning to Pre-Pregnancy BMI Prior to Pregnancy of Second Child, Washington State, 2003-2014**

Nicolas Dundas, Tyler Ketterl, Steven Roncaioli

Preceptor: Amanda Phipps

 **INTRODUCTION**: Maternal overweight and obesity is the most common high-risk obstetric condition associated with negative birth outcomes. Although maternal post-partum weight retention may be attributed to a variety of factors, little is known about the association between pre-pregnancy body mass index (BMI) and post-partum weight retention.

**OBJECTIVES**: The primary objective of this study was to examine the associations between pre-pregnancy BMI status and maternal weight retention.

**METHODS:** We conducted a population-based retrospective cohort study using Washington State birth certificate data from 2003-2013. We included mothers who had two sequential births during this time period, with the second birth occurring within 18-36 months of the first singleton delivery date. Pre-pregnancy BMI before a mother’s first pregnancy was categorized as normal (18.5-24.9kg/m2), overweight (25-29.9), or obese (30-40). Maternal weight retention was classified as having returned to first pre-pregnancy BMI +≤1 kg/m2 by the start of a second pregnancy. Analyses relating pre-pregnancy BMI to weight retention were stratified by gestational weight gain (GWG) during a first pregnancy (below, met, exceeded recommended GWG).

**RESULTS:** A total of 49,132 mothers were included in the study. Among mothers who met their recommended GWG, compared to mothers with a normal BMI, obese and overweight mothers were less likely to return to their pre-pregnancy BMI (72.3% vs 68.7%; RRObese = 0.91; CI: 0.87-0.94) (72.3% vs 65.6; RROverweight = 0.95; CI: 0.92-0.99) respectively. Among mothers who exceeded their recommended GWG, compared to mothers with a normal BMI, obese and overweight mothers were less likely to return to their pre-pregnancy BMI (53.2% vs 48.0%; RRObese = 0.90, CI: 0.87-0.92) (53.2% vs 50.5; RROverweight = 0.95, CI: 0.92-0.97) respectively.

**CONCLUSION:** Above normal pre-pregnancy BMI is associated with a decreased likelihood of returning to pre-pregnancy BMI. Obese mothers and their physicians should regularly be monitored for post-partum weight retention.

**Is the extra bedroom worth the extra perinatal stress? Maternal residence change during pregnancy and birth outcomes**

Julia Bond, Amanda Mancenido, Divya Patil

Preceptor: Jack Goldberg

**Introduction**: Psychosocial stress during pregnancy may adversely affect birth outcomes, although the evidence is inconsistent. Studies examining maternal psychosocial stress are often difficult to interpret because maternal stress is treated as a composite exposure of various stressful events occurring over all trimesters. Maternal residence change during pregnancy is an understudied source of maternal stress even though nearly 25% of US women move while pregnant. Our study assessed the effect of maternal residence change during the first trimester on birth outcomes including low birthweight, preterm birth, and any congenital malformation.

**Methods**: We conducted a population-based cohort study using Washington State birth certificate data from 2007 to 2014 (N=84,252). Women were categorized as first-trimester movers if estimated gestational age at birth subtracted from the estimated time at present residence was less than 12 weeks (n=4,252). Unexposed women were women in which estimated time at residence was longer than estimated gestational age. Analyses examined the cumulative incidence for each outcome and the associated relative risks and 95% confidence intervals. We used Mantel-Haenszel methods to assess potential confounding by demographic and maternal factors.

**Results**: We found that moving in the first trimester was associated with an increased risk of low birthweight (6.9% vs 4.7%, RR 1.46 [95% CI 1.30, 1.63]) and preterm birth (10.7% vs 6.9%, RR 1.55 [95% CI 1.42, 1.70]). There was no effect of moving on rates of congenital malformations. There was no evidence of confounding by any of the potential confounding factors.

**Discussion**: Our results suggest that moving during the first trimester of pregnancy may be a risk factor for adverse birth outcomes in United States women. Future studies should attempt to examine whether this association persists for women who move after the first trimester.

**Effects of hepatitis B infection on pregnancy outcomes in Washington State, 1992 – 2014**

Kristina Bajema, Helen Stankiewicz Karita, Mark Tenforde

Preceptor: Renee Heffron

**Introduction:** Hepatitis B virus (HBV) infection in pregnancy has been associated with risk of adverse maternal and infant outcomes in highly-endemic Asian settings. However, the association between HBV infection and adverse outcomes is not well characterized in the United States.

**Methods:** We conducted a retrospective population-based cohort study in Washington State using linked birth certificate and hospital delivery discharge records from 1992-2014. We examined the risk of gestational diabetes (GDM), pre-term delivery (PTD), low birthweight (LBW), and small for gestational age (SGA) comparing pregnant women with HBV identified from either database (n=4,391) to randomly-selected HBV-negative pregnant women (n=27,220) using stratified analysis and Mantel-Haenszel methods.

**Results:** HBV-infected pregnant women were more likely to identify as Asian (61% vs. 9%) and to be foreign-born (76% vs. 24%) and less likely to be overweight or obese (33% vs. 51%). Adjusting for age, race, country of birth, and pre-pregnancy BMI, HBV-infected women had a similar risk of GDM compared to HBV-negative women (aOR 0.99, 95% CI 0.85-1.15). There was also a similar risk of PTD in adjusted models (aOR 1.01, 95% CI 0.89-1.16). No significant difference was observed between groups for risk of LBW (aOR 0.92, 95% CI 0.79-1.07) or SGA (aOR 0.98, 95% CI 0.89-1.08).

**Discussion:** In a HBV low-burden setting in the United States, HBV infection was not associated with adverse maternal or infant outcomes.

**Maternal chorioamnionitis and neonatal sepsis: A population based case-control study in WA State**

Hang Yin, Monalisa Penumetsa, Stephanie Liu

Preceptor: Susan Reed

**Background:** Maternal chorioamnionitis is a risk factor for neonatal sepsis, an important cause of morbidity and mortality among infants, especially low birth weight babies. This study evaluated the association of chorioamnionitis and neonatal sepsis.

**Methods:** We conducted a population-based case-control study using data from Washington State birth certificates from 2003-2013 linked to the Washington Comprehensive Hospital Abstract Reporting System (CHARS). Cases and controls were randomly selected from all singleton livebirths four weeks of age or younger. Cases had neonatal sepsis (ICD-9 codes 771.81/995.91/995.92, n=7165). Controls were without CHARS sepsis codes and did not receive antibiotics as indicated on birth certificate (n=65,100). Exposure was maternal chorioamnionitis during labor (ICD-9 codes 762.7/658.4 and/or birth certificate). The odds ratio (OR) and 95% CIs were calculated by stratification analysis, with adjustment for birth year and parity. We also stratified by birth weight and time of sepsis diagnosis (birth hospitalization vs. readmission).

**Results**: Analyses included 72,265 neonates. Infants with neonatal sepsis were more likely to: be male, have low birthweight, have low Apgar score, be premature, and be born by cesarean. Infants with neonatal sepsis were more likely to have a mother who: was young (<25 years), was single, had high school education or less, had inadequate or intensive prenatal care, had an STI, had antibiotics during pregnancy, was a smoker, and was nulliparous. Infants with neonatal sepsis had a 9-fold increased risk of having a mother diagnosed with chorioamnionitis. The association was higher for normal birth weight infants [aOR: 9.3, 95%CI: 8.3, 10.4] than it was for low birth weight infants [aOR: 5.3, 95%CI: 3.7, 7.7]. The association was higher for neonates diagnosed with sepsis at birth compared to neonates who were readmitted to hospital with sepsis [aOR: 8.1, 95%CI: 7.3, 8.9 vs. 2.6, 95%CI: 2.0, 3.5].

**Conclusions:** Neonates hospitalized with sepsis were more likely to have mothers diagnosed with chorioamnionitis, particularly normal birth weight infants, and infants with birth hospitalization neonatal sepsis compared to readmitted infants. This finding could be explained by misclassification, or is real - suggesting a need to improve treatment of in utero infections to positively impact neonatal outcomes.

**Dads worth the weight: Examining the healthy immigrant effect among fathers on maternal and newborn weight outcomes**

Alexandra Akhunova, Katherine Garcia-Rosales, Michelle Passater

Preceptor: Babette Saltzman

**Background:** With the growing Asian immigrant population in the United States, it is becoming increasingly important to assess population-specific perinatal outcomes. The healthy immigrant effect (HIE) among women is known to impact these outcomes, yet few studies have evaluated the paternal component of HIE. This study assessed the association between paternal birthplace on maternal gestational weight gain (GWG) and small for gestational age (SGA) offspring among Asian immigrants in Washington State.

**Methods:** A retrospective cohort study using 2003-2014 birth certificate data from Washington state hospitals was conducted evaluating birth outcomes among singleton full-term live births to Asian couples. Due to smaller stature of this population relative to average stature for whom the norms regarding GWG and SGA were calculated in the US, population-specific GWG and SGA scales were constructed using 10th percentile cut-offs. Relative risks and 95% confidence intervals were calculated comparing the risk of low and high GWG and SGA among US-born father and Asian-born mother couples to these risks among Asian-born couples.

**Results:** Among Asian born mothers- those paired with US born fathers gained more weight than Asian born fathers (RR = 0.72; 95% CI = 0.61-0.86 and RR = 1.2; 95% CI = 1.0-1.4 of low and high GWG, respectively). When assessing SGA, stratified analysis showed that paternal race modified the risk for SGA in this population. Among Chinese and Vietnamese fathers, US-born fathers had a higher risk of SGA when compared to Asian-born couples (RR = 2.3; 95% CI = 1.4-3.8 and RR = 1.9; 95% CI = 1.8-3.0). The opposite association was observed among fathers of other Asian races (RR = 0.85; 95% CI = 0.72-1.0).

**Discussion:** Compared to Asian-born couples, having a US-born father was associated with higher maternal GWG. The risk of SGA varied among Asian race subgroups for couples with US-born versus Asian-born fathers. Because Asian immigrants comprise a large and diverse population, further research is needed to determine race-specific influences of paternal country of birth and risk of SGA. These findings may reflect differential pressures influencing immigration among Asians from different countries in Asia.

**Maternal Exposure to Animal/Crop Agriculture and Pediatric Hospitalizations Due to Acute Respiratory Illnesses in Washington State**

BreAnna Kinghorn, Kate McConnell, Orly Stampfer

Preceptor: Anjum Hajat

**Introduction**

Associations between exposure to animal and crop agriculture and pediatric acute respiratory illness are poorly understood. Studies suggest both protective and harmful effects of early life exposure to animal agriculture on pediatric asthma and wheeze. Growing research indicates that environmental exposures in utero may play a role in later respiratory health. We assessed the association between maternal exposure to animal and crop vs. crop only agriculture and pediatric respiratory outcomes.

**Methods**

We conducted a retrospective cohort study using data from the Comprehensive Hospital Abstract Reporting System. We used zip-code of residence listed on the Washington State birth certificate to define exposure to animal and crop agriculture. Eight zip-codes were classified as containing animal and crop agriculture. As comparison areas, we selected eight zip codes that contained only crop agriculture that were relatively comparable to the animal and crop agriculture areas in terms of ethnicity, education, income, and amount of crop agriculture. We analyzed 10,503 children from the animal and crop areas and 21,009 children from the crop only areas. All births occurred between 1989-2013. We used stratified analysis to assess associations between maternal exposure to animal and crop vs. crop only agriculture and respiratory hospitalizations within the first five years of life.

**Results**

Risk of pediatric hospitalization for acute respiratory illness was elevated in the group with maternal exposure to animal and crop agriculture relative to the group with maternal exposure to crop agriculture alone among Latinos (8.3% vs. 6.0%, RR=1.4; 95% CI: 1.2-1.4) and non-Latino non-Whites (8.4% vs. 4.2%, RR=2.0; 95% CI: 1.3-3.2), but there was no association among non-Latino Whites (4.8% vs. 5.4%, RR=0.9; 95% CI: 0.8-1.0).

**Discussion**

These results suggest that maternal exposure to animal agriculture may increase the risk of pediatric respiratory illness, but appears to differ depending on race/ethnicity. Despite limitations due to non-differential exposure misclassification, this study identifies maternal agricultural exposures as a health equity issue potentially affecting pediatric respiratory health.

**Association Between Delivery by Cesarean Section and Necrotizing Enterocolitis:** **A Case Control Study Among Washington State Infants**

Danae Black, Rachel Shaffer, and Stephanie Tornberg-Belanger

Preceptor: Noel Weiss

**Introduction**

Necrotizing enterocolitis (NEC) is the most frequently occurring neonatal gastrointestinal complication and is associated with serious morbidities and mortality. Previous work has documented differences in intestinal colonization in preterm infants based on mode of delivery, and differences in microbial diversity in the gut of infants with NEC compared to controls. We aimed to address the association of mode of delivery with the incidence of NEC in a population-based case-control study.

**Methods**

Birth certificate data were linked to the Comprehensive Hospital Abstract Reporting System (CHARS) database to identify cases of NEC (n = 755) during the years 1989-2013 in Washington State. Control infants without NEC (n=3775) who were born in Washington during this period were matched to cases on gestational age, but otherwise were selected at random. The odds ratio (OR) and 95% confidence interval (CI) were calculated to determine the association between mode of delivery (cesarean section (C-section) vs. vaginal delivery) and NEC. We evaluated the following factors for possible confounding: maternal age, maternal race, maternal smoking, birthweight, infant sex, and small for gestational age.

**Results**

A majority of infants with NEC were delivered by C-section (50.9%), in contrast to 41.1% of controls (OR = 1.5, 95% CI 1.3, 1.7). Adjustment for *a priori* selected confounders did not substantially alter the size of the association. The higher proportion of cases than controls delivered via C-section was present to a similar degree whether the infants’ mothers had diabetes, infection with group B streptococcus, or whether or not they were breast-fed.

**Discussion**

We detected a 50% increase in NEC incidence among infants delivered via C-section. Prior studies found C-section to be associated with reduced risk of NEC, which suggests cautious interpretations of our findings. Possible explanations for these differences may be explained by study inclusion criteria, study exclusion criteria, or alternative causal pathways.

**Maternal and Infant Risk Factors for the Development of Congenital Hemangiomas**

Matthew Dellinger, Kathleen O’Connell, Robert Tessler

Preceptor: Eric Chow

**Importance**: Congenital hemangiomas (CH) are vascular tumors that develop in utero and are present at birth. While evidence strongly supports an etiologic genetic component, few data exist on maternal or infant risk factors for congenital hemangioma (CH).

**Objective**: Our aim was to determine the association of maternal factors and infant birth characteristics with the development of congenital hemangioma.

**Design, Setting, and Participants**: Population-based case-control study using Washington state birth certificate data from 2003-2014. Cases were identified as singleton births with a hemangioma diagnosed at birth and were frequency matched 1:4 on birth year to infants without hemangiomas.

**Exposures:** Maternal exposures included maternal age, maternal race, gestational hypertension, diabetes, smoking, and prior cesarean section. Infant exposures included sex, preterm birth, low birth weight, small for gestational age, and 5-minute Apgar score.

**Main Outcome:** International Classification of Disease code version 9 for hemangioma diagnosed during the birth hospitalization.

**Results:** There were a total of 1,456 cases of CH and 5,824 year-matched controls with no CH. Cases were more likely to be female (59.0% v 48.8%), more frequently preterm (15.5% v 8.1%), and less frequently small for gestational age (7.4% v 9.4%). Mothers of CH infants more frequently had a prior cesarean section (12.8% v 7.7%), but had similar proportions of gestational hypertension, diabetes, and smoking during pregnancy. Multivariable logistic regression demonstrated higher odds of CH with maternal white race (OR 1.7, 95% CI 1.46-1.98), prior cesarean section (OR 1.76, 95% CI 1.46-2.14), infant female sex (OR 1.51, 95% CI 1.33-1.71), and low birth weight (OR 2.42, 95% CI 1.77-3.30) Small for gestational age (SGA) was associated with a lower odds of CH (OR 0.61. 95% CI 0.47-0.79).

**Conclusions and Relevance:** These data suggest an elevated risk for congenital hemangioma with preterm birth, infant female sex, maternal white race, and prior cesarean section. The mechanisms behind SGA and lower odds of CH may be related to prenatal growth restriction that precludes hemangioma development.

**The association between American Indian/Alaska Native maternal reservation residency and birth outcomes: a population-based cohort study in Washington State**

Nicholas Graff, Andrew Kwist, Ezekiel Maloney

Preceptor: Jesse Jones-Smith

**INTRODUCTION**

Risk for poor infant birth outcomes, including low birth weight (LBW), preterm birth, and small for gestational age (SGA) is elevated in American Indian and/or Alaskan Native (AI/AN) populations relative to the general population for reasons that are incompletely understood. Several health disparities have also been identified within AI/AN populations, yet little is known about factors that influence maternal-child health outcomes in these populations. The majority of AI/AN people do not live on tribal reservations, and there is uncertainty about whether there are differences in health outcomes for AI/AN people living off- versus on-reservation. We therefore hypothesized maternal reservation residency status would be associated with birth outcomes among AI/AN peoples.

**METHODS**

We conducted a population-based cohort study in Washington State using birth certificate data from singleton births to 15,890 AI/AN mothers between 2003 and 2014. 3,178 births to mothers living on tribal reservations and 12,712 births to mothers living off-reservation were identified. Births were frequency matched by delivery year. Relative risks (RR) for the association between maternal reservation residency and LBW, preterm birth, and SGA were estimated, and adjusted for maternal marital status (married, unmarried) and maternal age (< 20, 20-25, 25-34, >35 years) using the Mantel-Haenszel method.

**RESULTS**

In multivariable adjusted models, living on a reservation (versus not living on a reservation) was associated with a higher risk of preterm birth (12% vs 10%, RR = 1.2, 95% CI: 1.1 – 1.4), and a lower risk of SGA (6.8% vs 8.4%, RR = 0.76, 95% CI: 0.66 – 0.88). Living on a reservation (versus not living on a reservation) was not associated with LBW (7.3% vs 6.2%, RR = 1.1, 95% CI: 0.99 – 1.3).

**DISCUSSION**

Maternal reservation residency was associated with decreased risk of SGA and increased risk of preterm birth, while there was no association with LBW. SGA and preterm birth can be the result of distinct physiologic mechanisms, so risk estimates for each outcome can be divergent, as we have observed in this study. Further research into any underlying differences in risk factors for these outcomes may inform interventions to improve AI/AN maternal-child health.

**Predictors of Maternal Smoking Cessation During Pregnancy in Washington State, 2003-2014**

Kathleen Kearney, Robert Lee, Laura Spece

Preceptor: Alyson Littman

**Introduction:** Despite recent changes in local legislation to deter smoking in Washington State and an overall decline in prevalence, 8% of women report smoking through the 3rd trimester of pregnancy. Little is known about contemporary predictors of smoking cessation during pregnancy. Understanding predictors of tobacco cessation during pregnancy may reveal novel sub-groups to target for interventions to reduce smoking in pregnancy.

**Methods:** We conducted a case-control study amongst pregnant smokers in Washington State between 2003-2014. We identified 16,500 women who quit by the 3rd trimester and frequency matched them to controls 1:3 on year of birth. Main exposures of interest included prenatal care, prepregnancy smoking quantity, and parity and were ascertained from self-reported birth certificate data. The Kotelchuck index was used to measure adequacy of prenatal care. We used Mantel-Haenszel adjustment to control for maternal age, marital status, education and receipt of WIC benefits as a proxy for socioeconomic status.

**Results:** Women with inadequate prenatal care were half as likely to quit smoking (OR 0.47, 95%CI 0.45-0.50 versus adequate care) as was lower maternal socioeconomic status (receipt of WIC versus not: OR 0.66, 95% CI 0.63 to 0.68). Smoking 20 or more cigarettes per day (versus <10 cigarettes) was associated with decreased odds of smoking cessation (OR 0.70, 95% CI 0.70-0.73). Women giving birth for the first time had a nearly two-fold increased odds of smoking cessation (OR 1.91, 95%CI 1.84-2.0 versus multiparous women.) Associations did not vary by pre-pregnancy smoking quantity, parity, or education.

**Discussion:** Inadequate prenatal care was an important, potentially modifiable risk factor for persistent smoking during pregnancy. Women who reported heavy smoking, lower socioeconomic status, and a prior history of pregnancy were identified as high-risk groups for continued smoking during pregnancy, and may be important targets for smoking cessation interventions and increased support. Further study regarding the impact of improving prenatal care and success of smoking intervention in high-risk groups is warranted.

**Short Changed: The Association Between Maternal Stature and Infant Outcomes**

Sebastian Jara, D. Allen Roberts, Francys Verdial

Preceptor: Christopher Li

**Introduction**

Low birth weight (LBW), preterm birth (PTB), and delivery by Cesarean-section remain substantial causes of neonatal morbidity in the United States. Maternal stature is an important marker of maternal health, reflecting the lifetime cumulative effects of genetic predispositions and environmental exposures, and may play an important role in neonatal outcomes in pregnancy. We sought to evaluate the association between maternal short stature and these neonatal outcomes.

**Methods**

We conducted a population-based retrospective cohort study among nulliparous women 18-40 years of age in Washington (WA) State. Data were collected from WA state birth certificates recorded between 2004 and 2014. We defined short stature as height <152cm and used 4:1 frequency- matching on birth year to select a sample of women of normal stature (152cm-174cm) for comparison. Outcomes measured included LBW (birth weight <2500g), PTB (birth <37th week of gestation), and delivery by Cesarean-section. For each outcome, we used the Mantel-Haenszel test to calculate relative risks and 95% confidence intervals adjusted for maternal education and/or ethnicity. As a sensitivity analysis, we divided the normal stature comparison group into four groups based on maternal height and used a log-binomial regression model to evaluate whether the relative risk of low birth weight differs across height categories.

**Results**

A total of 9,297 births to mothers of short stature were included in the study, resulting in a total cohort of 46,485 births. When compared to neonates from mothers of normal stature, neonates from mothers of short stature were at higher risk of PTB (RR 1.30, 95% CI: 1.24-1.37) and Cesarean-section (RR 1.50, 95% CI: 1.46-1.55). Maternal ethnicity and body mass index (BMI) were found to modify the association between short stature and LBW. Risk of LBW was elevated 53%-164% among non-Hispanic mothers regardless of BMI, and only among underweight and normal weight Hispanic mothers. Regression analysis demonstrated a dose-response relationship between maternal height and LBW risk. Among non-Hispanic, underweight mothers, the relative risk of LBW compared to mothers between 160-162 cm was 2.12 (95% CI: 1.31-3.44) among short stature mothers but only 0.71 (95% CI: 0.41-1.22) among mothers 168-174 cm.

**Discussion**

Neonates born to mothers of short stature may be at higher risk of adverse infant outcomes, particularly those born to underweight and non-Hispanic women. An understanding of this relationship should be taken into account in appropriately risk-stratifying women of short stature.

**Examining Risk Factors of Re-Hospitalizations for Adverse Outcomes Following Conservative Management of Postpartum Hemorrhage**

Michael Truong and Gabriella Veytsel

Preceptor: Daniel Enquobahrie

**Background**: Postpartum hemorrhage (PPH), defined as uterine bleeding of at least 500 ml after vaginal delivery or 1000 ml after Caesarean section, is a major cause of maternal morbidity and mortality worldwide. Hysterectomy (removal of the uterus) is often the standard treatment for PPH; however, conservative management (CM) aims to avoid hysterectomy by utilizing adjunctive methods to reduce blood loss and, in cases of placental retention, expedite placental resorption or expulsion.

**Methods:** We conducted a population-based case-control study using Washington state birth certificate data from 1992-2012 linked to the Washington Comprehensive Hospital Admission Reporting System (CHARS) database, which contains maternal and infant hospital discharge data, as well as maternal readmissions data. Cases, defined as mothers who experienced re-hospitalization for adverse events (n=271), were frequency matched to controls (n=2710) by birth year. Hence, the outcome measured was hospital re-admission for hysterectomy, delayed PPH, endometritis, endomyometritis, sepsis, and coagulothapy. Exposures examined were parity, preeclampsia, race/ethnicity, antibiotic use during delivery, adequacy of prenatal care utilization, infant birth weight, maternal age, induction of labor, diabetes, and prolonged labor.

**Results**: Population maternal characteristics were generally indicative of low-risk pregnancies. Maternal factors associated with greater risk of re-hospitalization following CM were preeclampsia (OR = 1.73, 95% CI: 1.12-2.61) and intensive prenatal care utilization (compared to adequate utilization, OR =1.45, 95% CI: 1.04-2.03). Maternal factors associated with lower risk of re-hospitalization were primiparity and multiparity (compared to nulliparity, OR = 0.6, 95% CI: 0.44-0.83 and OR = 0.74, 95% CI: 0.54-0.99, respectively), use of antibiotics during delivery (OR = 0.62, 95% CI: 0.36-0.99), and inadequate prenatal care utilization (compared to adequate utilization, OR = 0.59, 95% CI: 0.36-0.96). Amongst those with intermediate or adequate prenatal care utilization, non-White mothers were less than half as likely to experience re-hospitalization compared to White mothers (aOR = 0.32, 95% CI: 0.13-0.76 or aOR = 0.47, 95% CI: 0.26-0.84, respectively).

**Discussion**: To our knowledge, this is the first study examining re-hospitalizations due to adverse outcomes following CM and the largest study of CM to control for PPH. Providing insights on maternal risk factors associated with re-hospitalization for adverse events and elucidating the most common adverse events with their average time to occurrence post-delivery, findings from this study can guide patient counseling and clinical care in PPH management.

**Predictors of a Successful External Cephalic Version: A Population-Based Case-Control Study of 2003-2014 Washington State Births**

Audrey Brezak, Audrey Hu, Erin Morgan

Preceptor: Stephen Hawes

**Introduction:** Breech presentation occurs in approximately 3% of all singleton pregnancies carried to term. External cephalic version (ECV) is a procedure used by health professionals to manually orient a breech fetus to the cephalic position late in gestation, typically around 36 weeks, in preparation for delivery. The primary aim of this study is to evaluate factors associated with the success of ECV attempts.

**Methods:** We conducted a population-based, case-control study using birth certificate data. The study population includes all singleton pregnancies with an attempted ECV procedure that delivered in Washington State between 2003-2014 (total n= 3,554; 41.8% successful). Logistic regression was used to calculate odds ratios and confidence intervals.

**Results:** Higher parity was a predictor of success, primiparous women were more likely to be successful (OR: 2.40; 95% CI: 1.98 – 2.92) and multiparous women even more so (OR: 4.33; 95% CI: 3.47 – 5.41). Obese women were less likely to be successful (OR: 0.57; 95% CI: 0.37 – 0.86)

**Discussion:** Consistent with other studies, this analysis found that previous pregnancy is predictive of greater success in ECV attempts and greater BMI is associated with reduced success. Previous studies have not investigated characteristics such as maternal height, prenatal care, or year of birth. This study is one of the largest investigations of this question and is population-based. Birth certificate data has some limitations; not all relevant information is recorded, and the accuracy of ECV success is unknown. This study can inform clinicians as to which mothers are best candidates for an ECV procedure.

**HEALTHY IMMIGRANT EFFECT ON BIRTH OUTCOMES IN US-BORN NATIVE WASHINGTON WOMEN COMPARED TO NON-WASHINGTON BORN US WOMEN**

Beatrice Wamuti, Eliud Akama, Irene Mukui

Preceptor: Chris Delaney

**Background:** Foreign-born women migrating from developing countries have been known to have better birth outcomes than the native-born women in developed countries; a phenomenon referred to as the *healthy immigrant effect*. This phenomenon is, however, not well understood among domestic migrant populations within the US. The objective of this study was to determine whether there is a *healthy immigrant effect* on birth outcomes among US-born women comparing native Washington (WA) State women to non-Washington (non-WA) State women.

**Methods:** We  conducted aretrospective cohort study using de-identified Washington State Vital Statistics Birth Certificate (BC) Records from 2005-2014. We sampled 100,000 mothers (10,000 per year) who were frequency matched at 4:1 by birth year, for a total of 20,000 WA and 80,000 non-WA mothers. Women born in WA State formed the reference group. The birth outcomes of interest were Small for Gestational Age (SGA), Low Birth Weight (LBW), and preterm birth.  We conducted descriptive analysis and multinomial logistic regression.

**Results:** Demographic characteristics were similar between WA and non-WA women. There was no association between state of mother’s birth and birth outcomes: LBW (crude Relative Risk (RR): 1.01, 95% Confidence Interval (CI): 0.95 -1.09), preterm birth (crude RR: 1.05, 95% CI: 1.00-1.11) and SGA (crude RR: 1.01, 95% CI: 0.96-1.06), with no evidence of interaction or confounding. In the exploratory analysis, mothers from the South seemed to have increased risk for LBW, preterm birth and SGA.

**Discussion:** Region of mother’s birth was not associated with birth outcomes when comparing WA to non-WA State mothers. Mothers from the South seemed to have a higher risk for LBW, SGA and preterm births.

**Conclusion:** We found no evidence of the *healthy immigrant effect* among US women internally migrating from other US States into WA State. Further analysis is needed to determine heterogeneity in birth outcomes by region of mother’s birth among women migrating to WA State.

**Risks for Non-Syndromic Orofacial Clefts by Rural vs Urban Residence and Race/Ethnicity: Washington State 1989-2014**

Flavia Kapos, Kelsey Schmidt, Lauren White

Preceptor: Jacqueline Starr

**Introduction:**

Orofacial clefts (OFC) are among the most prevalent birth defects (~1:700 live births), resulting in increased healthcare, financial and psychosocial burden. The aetiologies of OFCs are multifactorial, but only a small proportion of cases are explained by known risk factors. This study evaluates the association of OFC risk with a) rural versus urban maternal residence and b) race/ethnicity. Additionally, we assess whether these relationships differ relative to mandated folic acid fortification.

**Methods:**

We conducted a population-based case-control study using Washington State birth certificates from 1989-2014 linked to the Comprehensive Hospital Abstract Reporting System. The odds ratios (OR) for OFC were calculated using Mantel-Haensel stratified analysis by rural versus urban residence and maternal race/ethnicity comparing infants with non-syndromic orofacial clefts (n=2,136) with randomly selected controls (n=12,916), frequency matched 5:1 by birth-year. The ORs for OFC by the two exposures of interest were stratified by year of conception (1989-1995 vs. 1998-2014) and compared qualitatively and by Breslow-Day test for heterogeneity.

**Results:**

Infants born to mothers of rural residence had 19% (95%CI: 7%, 32%) higher risk for OFC. Compared with infants born to White mothers, infants born to Native American mothers had 70% (95%CI: 34%, 116%) higher risk for OFC. Conversely, infants born to Hispanic, Asian/Pacific Islander, and Black mothers had a lower risk for OFC (ORs 0.65-0.82). Risk for Asian/Pacific Islanders compared to Whites was reduced after 1997, a difference not observed for other maternal race/ethnicity categories or rural vs. urban maternal residence. Adjustment for maternal race/ethnicity, rural vs. urban residence, age, marital status, education, census tract income, smoking, pre-natal care (Kotelchuck Index), pre-pregnancy diabetes, BMI, parity and paternal age did not substantially change our results.

**Conclusions:**

Consistent with two previous studies, infants born to mothers living rurally are at a higher risk for OFCs; future studies should explore potential underlying mechanisms, such as occupational and environmental exposures. This is the second report of changes in OFC risk by race over time. The relative reduction of OFC risk in Asian/Pacific Islanders after 1997 may represent a greater etiological contribution of folic acid deficiency in this population before the fortification.