The Risk of Pregnancy Associated Hypertension among Immigrants to Washington State from 2003-2013

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Abstract

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OBJECTIVE: This study sought to determine if immigrants to Washington State had a decreased risk of pregnancy associated hypertension when compared to racially similar women born in the United States between 2003 and 2013.

STUDY DESIGN: This retrospective cohort study used linked Washington State birth certificate (BC) and Comprehensive Hospital Abstract Reporting System (CHARS) data to evaluate the incidence of hypertensive disorders of pregnancy between the years 2003 - 2013. The study population consisted of the most common immigrant groups to Washington State with similar geographic area of birth: 1) North East Africa: Somalia and Ethiopia; 2) Eastern Europe: Russia and Ukraine; 3) Asia: India, Philippines, Vietnam, China and Korea; and 4) Hispanic America: Mexico. The control population consisted of United States (U.S.) born women, divided by self-identified racial subgroups (Black, White, Asian, Hispanic). The primary outcome was pregnancy associated hypertension. Confounding was evaluated by assessing risk factor variables: maternal age, pre-pregnancy BMI, weight gain during pregnancy, parity, diabetes, history of pre-existing chronic hypertension, multifetal gestations, smoking status, maternal education, paternal education, insurance type, median neighborhood income, and marital status. Multivariate

regression methods assessed the association between pregnancy associated hypertension and a mother's country of origin.

RESULTS: Crude analysis confirmed that U.S. immigrants from all countries except the Philippines (OR=1.22) had lower risk of developing pregnancy associated hypertension as compared to U.S. born women of similar racial background (crude OR to develop PAH varied from 0.37 to 0.67 as compared to U.S. born women). After adjusting for the aforementioned risk factors, multivariate regression revealed that U.S. born women still have higher risk of developing pregnancy associated hypertension than U.S. immigrants born in Ethiopia, China, and Vietnam (OR =0.72, 0.51, 0.57). Immigrants born in Russia, India, Korea, and Mexico approached the same risk of developing PAH as compared to U.S. born women (OR=0.85, 0.82, 0.81, 0.84). However, the decreased risk of developing pregnancy associated hypertension in immigrant women from Ukraine (OR=0.92, CI 0.82, 1.04); and Somalia (OR=1.11, CI=0.87, 1.42) equaled the risk of U.S. born women.

CONCLUSION: Country of origin is an independent risk qualifier of maternal hypertensive disorders. With the exception of Filipina women, U.S. immigrants from ethnically varied geo-political countries have lower crude risk than their U.S. born and racially similar counterparts. After multivariate adjustment, women from the Ukraine and Somalia have similar risk of pregnancy associated hypertension as U.S. born women of similar racial background. Obstetric protocols and practice management may be changed to more accurately stratify pregnancy associated hypertension risk assessment by immigrant status rather than solely on race.

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BACKGROUND

Maternal hypertensive disorders of pregnancy are the leading cause of maternal mortality in the U.S., responsible for 16.1% of all maternal deaths.[1] It has previously been shown that there is a paradoxical immigrant effect such that many immigrants have improved birth weight and full term birth outcomes as compared to their U.S. born counterparts. The paradoxical immigrant effect is not well studied regarding hypertensive disorders of pregnancy.[2] Current obstetric practice estimates risk for hypertensive disorders by race, and not by immigrant status or country of origin.[3] In the current medical climate of value-based medicine, emphasis is being placed on categorizing pregnancies to low-risk and high-risk pathways or bundles. It is therefore important to properly recognize which patients may be at increased risk for the most common cause of maternal mortality.

A report in 2013 referred to data collected from 1997 to 2002 identifying the leading cause of maternal death in developed countries as hypertension (16.1%) followed by embolism (14.9%) and hemorrhage (13.4%).[1] In the United States, the risk of hypertensive disorders of pregnancy varies by race; African-Americans have the highest risk (approximately 8.5%), followed by Hispanics (~6.2%), White/Caucasians (~5.5%), and Asian-Americans (~3-4%).[4,5] The 2017 U.S. Task Force Preventive Services report approximated rates of pre-eclampsia between 3 and 8%[3],however this report included pre-eclampsia and not all hypertensive disorders of pregnancy. Previous studies that evaluated differences in hypertensive disorders of pregnancy among racial or ethnic sub-groups have not differentiated between patients born in the U.S. versus patients born outside of the U.S.[6] For example, A 2003 U.S. national study comparing subgroups of Asian-Americans revealed a varying incidence of pregnancy associated hypertension from 1% to 2.9% between Vietnamese and Filipina women, but this study did not discern between U.S. born and immigrant women.[6]

There are international studies about the immigrant effect of other perinatal outcome measures, but literature review did not reveal any study addressing the immigrant effect on hypertensive disorders of pregnancy. Some studies revealed favorable perinatal outcomes in the immigrant populations and some showed unfavorable outcomes. Unfavorable immigrant studies include U.S., European, and Australian

studies that show Somali immigrants possess an increased risk for cesarean sections associated with fetal distress, failed induction of labor, delivery beyond 42 weeks or late term birth, and significant perineal laceration and poor neonatal outcomes.[7-10] There are also favorable immigrant outcome studies. Canadian studies showed decreased risk for preterm deliveries in immigrant populations as compared to Canadian-born parents. Those same immigrant deliveries were less likely to be preterm than published rates of preterm delivery in the immigrants native country.[11] The risk of preterm birth increased (worsened) the longer an immigrant lived in Canada[12], as if there were a protective immigrant effect that diminished over time. On the other hand, the rate of stillbirth was higher in immigrants who came from a country with high stillbirth rates.[13] These studies did not compare immigrant patients to racially or ethnically similar patients in receiving countries. Studies of Eastern European immigrants to the United States show decreased risk of preterm birth and small for gestational age babies when compared to U.S. born non-Hispanic Whites.[14] Korean immigrant women have also been shown to have decreased risk of preterm birth when compared to U.S. born White women.[15] These studies did not evaluate hypertensive disorders of pregnancy.

The incidence of hypertensive disorders of immigrants to European countries has been compared to native Europeans, but these studies did not stratify by ethnic origin.[16] Studies comparing Israelis to Ethiopian and Russian immigrants show Ethiopian immigrants had an incidence of pre-eclampsia of 4.0% vs 6.8%.[17] Ethiopian immigrants who moved to Israel had higher perinatal mortality than Israeli born patients. Russian immigrants to Israel had lower perinatal mortality than Israeli born patients.[16] Furthermore, the prevalence of diabetes and hypertension was higher in Ethiopian immigrants and increased the longer the patient lived in Israel. [18] Canadian researchers evaluated hypertensive disorders in Filipina women compared to Canadian women, and found increased rates of hypertension.[19] Again, these researchers did not compare the immigrant population to women of a similar race or ethnic origin.

The incidence of maternal hypertensive disorders varies by different racial backgrounds. The United States Preventive Task Force (USPTF) uses African American race as a risk factor to determine if a patient may have a higher risk to develop hypertensive disorders of pregnancy.[20] African American

women have case fatality rates from preeclampsia that are 3 times higher than those of White women.[20] Inequalities in access to adequate prenatal care may contribute to a more severe onset of preeclampsia in African American women.[20] Country of origin has not been studied as an independent risk qualifier of maternal hypertensive disorders.[21] If immigrants have lower risk than their U.S. born and racially similar counterpart, then protocols and practice management may be changed to more accurately assess and treat obstetric patients.

MATERIALS AND METHODS

This retrospective cohort study used linked Washington State Birth Certificate (BC) and Comprehensive Hospital Abstract Reporting System (CHARS) data to evaluate the incidence of hypertensive disorders of pregnancy between the years 2003 - 2013. This data was obtained from Washington State Department of Health. The Washington State Institutional Review Board determined that the study met criteria for exempt status and did not need a full institutional review board approval.

The study population consisted of the most common immigrant groups to Washington State with similar geographic area of birth: 1) North East Africa: Somalia and Ethiopia; 2) Eastern Europe: Russia and Ukraine; 3) Asia: India, Philippines, Vietnam, China and Korea; and 4) Hispanic America: Mexico. Immigrants born outside of the U.S. were considered “exposed” while U.S. born patients were considered “unexposed.” These “exposed” populations were compared to their racially similar U.S. born “unexposed” controls, respectively: U.S. born Black, U.S. born White, U.S. born Asian, and U.S. born Hispanic. Mixed race mothers were excluded. Repeated births to the same mother were also excluded (one birth, chosen randomly, was included in the dataset).

Racial identifiers are included on CHARS data and on birth certificate data. Previous studies have shown that in Washington most medical conditions and complications of pregnancy that affect mothers are substantially underreported on birth certificates, but hospital discharge data are accurate.
Together, birth certificate and hospital discharge data are much superior to birth certificates alone in

the reporting of pregnancy associated hypertension.[22] If there were a discrepancy between CHARS and BC race identifiers, preference was given to the CHARS identified race. This study used terminology in accordance with CHARS variable labels; "Black," "White," "Asian," and "Hispanic." U.S. born "Black" women are also referred to as African American. The maternal country of origin was gathered from BC data. Maternal country of birth is not collected on the CHARS database.

The total number of patients who delivered in Washington State between 2003 and 2013 were approximately 680,160 (White), 39,530 (Black), 82,190 (Asian), and 10,222 (Hispanic). The maternal country of origin subgroups during this time included Ethiopia 3768, Somalia 4552, Mexico 15,068, Ukraine 10,426, Russia 5431, Philippines 11,584, India 13,130, Korea 7326, and China 6844. Four exposure groups were created. The Black exposure group matched four unexposed (U.S. born Black, n=16,908) per one exposed (born in Ethiopia and Somalia, n=4,701) frequency matched by year. The White exposure group matched ten unexposed (U.S. born White, n=92,380) per one exposed (born in Ukraine and Russia, n=9,238). The Asian exposure group matched one unexposed (U.S. born Asian, n=5,208) to five exposed (born in China, Philippines, India, Korea, Vietnam, n=26,040). The Asian unexposed subgroup was comprised of women with heterogeneous Asian ethnic origin: 1221 Chinese, 2250 Filipino, 538 Asian Indian, 665 Korean, and 534 Vietnamese (Table 4C). The Hispanic exposure group matched one unexposed (U.S. born Hispanic, n=16,632) to three exposed (born in Mexico, n=49,896). The U.S. born control group was not divided into ethnic origin to preserve power in the model. Future models could stratify U.S. born controls by ethnic origin.

Cases of pregnancy-associated hypertension (PAH) were identified from ICD-9 codes, found in CHARS and/or BC data. All diagnoses of maternal hypertensive disorders from CHARS and BC were included, even when only one of the two data sources included a hypertensive diagnosis. Inclusion from both sources increased the sensitivity of identifying cases. Cases that did not include *any* ICD-9 codes or BC diagnoses were excluded from the dataset, so that patients without pregnancy associated hypertension were not over-represented due to incomplete CHARS and BC data.

There are over thirty ICD-9 codes specific for pregnancy associated with hypertension. All codes begin with 642.**; the last two numbers define different subtypes of hypertension in pregnancy. Renal hypertension includes codes ending in .10, .11, .13, .20, .21, .23. Transient or gestational hypertension includes codes ending in .30, .31, .32, .33, .34. Pre-eclampsia includes codes ending in .40, .41, .43. Severe pre-eclampsia codes end in .50, .51, .52, .53, .54. Eclampsia codes end in .61, .62, .64. The diagnosis of hypertension *affecting*, *complicating*, or *during* pregnancy ends in codes .90, .91, .92, .93, .94. For the outcomes analysis, the different subtypes of hypertension in pregnancy were pooled. This CHARS data was combined with BC diagnoses that identified patients with pre-eclampsia and eclampsia. This combined data represented the primary outcome, "pregnancy associated hypertension," or PAH.

Pre-existing hypertension (ICD-9 code 642.0*) was considered a risk factor variable, not an outcome. Essential, benign, or pre-existing hypertension includes codes ending in .00, .01, .02, .03, .04. The CHARS cases with ICD-9 codes for pre-existing hypertension were combined with BC cases that included the diagnosis of chronic hypertension.

Risk factor variables were selected based upon previous studies that identified risk factors for pregnancy associated hypertension, or maternal hypertensive disorders[4,19,20,23-27]. Known PAH risk factors obtainable from the linked CHARS and BC data base include maternal age categories (less than 20 years old, or greater than 35 years old), weight gain during pregnancy, pre-pregnancy body mass index (BMI), smoking (decreases risk), parity (nulliparity has higher risk), diabetes, a history of pre-existing hypertension or chronic hypertension, and twins or multifetal gestations. These were labeled "maternal risk factors." Previous studies have suggested that socio-economic factors that contribute to a lack of access to medical care are related to worse cases of pregnancy associated hypertensive disorders.[20] Lower socioeconomic status is a marker for a complex set of poorly understood factors that seem to carry a higher risk of heart disease, including hypertension.[28] Maternal and paternal education, marital status, insurance type, and median neighborhood income were chosen and labeled "socio-economic risk factors." Collectively, maternal risk factors and socio-economic risk factors are referred to as "risk factors."

Separate models were built for each racial subgroup. Crude analysis for the risk of developing PAH for each country of origin was initially assessed. Multivariate logistic regression analysis was used to evaluate the risk of developing PAH in relationship to each individual risk factor variable and countries of origin. The odds ratios from these two analyses were compared. Risk factor variables that changed the crude to multivariate odds ratio by more than 5% were identified as confounders. A multivariate logistic regression model was built for each racial exposure group, assessing immigrant country of birth compared to a racially similar control group of US born women. These four multivariate regression models estimated the odds ratios and 95% confidence intervals associated with PAH, adjusting for factors identified as confounders of the association between country of birth and PAH.

The coding and data analysis for this paper was generated using STATA /IC software, Version 14.2 (StataCorp, College Station, Texas USA).

RESULTS

Results for Immigrants from Eastern African countries and U.S. Born African Americans

The study populations differed in several risk factor categories (Table 1A). Mothers from Ethiopia were older, less likely to gain excessive weight during pregnancy, less likely to have a high pre-pregnancy BMI, less likely to be multiparous, were more educated, less likely to be married, less likely to be on Medicaid, and more likely to live in a higher income neighborhood than Somali immigrants. When compared to U.S born African Americans, Ethiopian women were older, less likely to be obese, less likely to smoke, less likely to have chronic hypertension, more likely to have diabetes, and more likely to be married. Somalia born mothers were older, less likely to be obese, smoke, have chronic hypertension, be nulliparous, and were more likely to have diabetes than U.S. born African Americans. With regards to socio-economic factors, Somali women were less likely to be educated, more likely married, more likely on Medicaid, and live in neighborhoods with lower median incomes than either Ethiopian or US-born African American mothers.

Crude analysis showed women born in Somalia (OR=0.66), and Ethiopia (OR=0.61) have lower risk of pregnancy associated hypertension (PAH) than African Americans born in the United States (Table 2A). Confounders for the African-American exposure subgroup were maternal age, weight gain during pregnancy, pre-pregnancy BMI, and chronic hypertension. After adjusting for these factors in the multivariate analysis, Ethiopians continued to have a lower risk of developing PAH as compared to U.S. born African Americans (OR = 0.72, CI= 0.59, 0.88) (Table 3A). However, Somali mothers had similar risk of developing pregnancy associated hypertension as U.S. born African Americans (OR=1.04, CI= 0.86, 1.26).

Results for Immigrants from Eastern European countries and U.S. born Whites

A greater percentage of babies born to U.S. born White women (16%) were born to women less than 20 years old as compared to immigrant Ukrainian (1%) and Russian (3%) women (Table 1B). U.S. born White women also had increased weight gain during pregnancy, higher rates of overweight and obesity, and smoked more (decreased risk of PAH),(Table 2A). U.S. born women having babies were less likely to be married, and more likely to have private insurance than Russian or Ukrainian immigrant women.

A larger proportion of U.S. born White women have pregnancy associated hypertension risk factors as compared to immigrants from the Ukraine and Russia (Table 2B). Crude analysis confirms U.S. born White women develop pregnancy associated hypertension (PAH) more frequently than either Ukrainian (OR=0.67) or Russian (OR=0.67) women. Confounders for the White exposure subgroup were weight gain during pregnancy, pre-pregnancy BMI, parity, diabetes, and paternal education. Multivariate logistic regression analysis predicted Russians would approach the same risk of developing PAH as U.S. born Whites (OR = 0.86, CI= 0.73, 1.00) and Ukrainian mothers would have a similar risk of developing PAH as U.S. born Whites (OR=0.92, CI= 0.82, 1.03) (Table 3B).

Results for Immigrant Women born in Asian countries and U.S. born Asians

Review of the frequencies and percentages of maternal risk factors shows a relatively similar maternal risk factor distribution across all countries of origin (Table 1C). A higher percentage of U.S. born Asians having babies are less than 20 years old, but more women from China, the Philippines, Korea, and Vietnam are older than 35. There is only a slightly increased proportion of increased weight gain, overweight or obese U.S. born Asians as compared to the other countries, other than the Filipina women who have similar rates as the U.S. Fewer U.S. born Asians had pre-gestational or gestational diabetes. Review of socio-economic risk factors reveal that more than 50% of immigrant Chinese and Indian fathers and more than 40% of immigrant Chinese and Indian mothers have graduate degrees.

Crude analysis suggests women who are born in the Philippines have a higher risk of pregnancy associated hypertension (PAH) than U.S. born Asians (OR=1.22, CI=1.07, 1.40) (Table 2C). Women from other Asian countries have lower risk of developing PAH. As compared to U.S. born Asians, the crude OR of developing PAH for China =0.37, India =0.65, Korea=0.67, and Vietnam=0.46.

The Asian U.S. born control group is skewed by increased representation of Filipina and Chinese ethnicity (Table 4C). However, the percentage of each U.S. born control continues to show increased risk of PAH when stratified by ethnic origin (Table 3C1).

Confounders in the Asian exposure group were maternal age, weight gain during pregnancy, pre-pregnancy BMI, parity, a history of chronic hypertension diabetes, and paternal education. Multivariate logistic regression revealed Filipina women continue to have a higher risk of developing PAH as compared to U.S. born Asians (OR=1.36, CI=1.15, 1.60) (Table 3C). Chinese (OR=0.51, CI= (0.40, 0.65) and Vietnamese (OR=0.58, CI=0.47, 0.72) immigrants continue to have significantly lower PAH than U.S. born Asians. Asian Indian (OR=0.82, CI=0.69, 1.00) and Korean (OR=0.81, CI=0.66, 0.96) immigrants' risk approaches that of U.S. born Asians.

Results for Mexican born immigrants and U.S. born Hispanic Women

U.S. born Hispanic pregnant women are more likely to be less than 20 years old, smoke, have fewer children, less likely diabetic, are more educated, have more educated fathers, and are more likely to have private insurance (Table 1D).

Crude analysis indicates that immigrant women from Mexico have lower risk of pregnancy associated hypertension (PAH) than U.S. born Hispanics (OR=0.66, CI=0.62, 0.71) (Table 2D).

Confounders included maternal age, weight gain during pregnancy, pre-pregnancy BMI, parity, diabetes, maternal education, and insurance type. A multivariate logistic model adjusting for these maternal and socio-economic confounders indicates the risk for PAH of women born in Mexico approaches the risk of U.S. born Hispanics but remains significantly lower. (OR=0.87, CI=0.80, 0.95) (Table 2D).

DISCUSSION

The healthy immigrant effect exists for most, but not all of the immigrant populations studied when matched to U.S. born women of similar racial backgrounds. Although in crude analysis we observed that all but Filipina immigrants have lower risk of developing pregnancy associated hypertension, multivariate logistic regression and adjustment for confounding risk factors reveals varying amounts of this residual healthy immigrant effect for the different countries of origin. Ethiopians, Chinese, and Vietnamese mothers continued to have significantly lower risk of developing PAH compared to US-born mothers of similar race, after adjusting for confounding risk factors. Russian, Mexican, Asian Indian, and Korean mothers continue to have lower risk of developing PAH, but their odds ratios to develop PAH approached that of U.S. born women of similar race (ORs varied from 0.81 to 0.87). Somali and Ukrainian women portrayed more significant confounding, and after adjustment the odds ratios for Somali (OR=1.09, CI=0.88, 1.35) and Ukrainian (OR=0.93, CI= 0.82, 1.03) women were similar to U.S. women of similar race. Filipina immigrants continue to have increased risk of pregnancy associated hypertension (OR=1.36, CI=1.15, 1.60) compared to US-born Asian mothers.

The decreased risks of pregnancy associated hypertension in immigrants are only partly explained by differences in the most commonly cited maternal risk factors: maternal age, pre-pregnancy BMI, weight gain during pregnancy, diabetes, pre-existing chronic hypertension, nulliparity, multifetal gestations, and smoking (decreased risk). Some degree of confounding occurred for all cohorts. Maternal risk factor variables that consistently demonstrated confounding across all exposure groups included pre-pregnancy BMI, weight gain in pregnancy, and parity. Differential risk factors explained differences in PAH in select cohorts, but not all cohorts. Diabetes confounded the relationship between PAH and both White and Asian immigrants. Chronic hypertension confounded the relationship between PAH and Blacks and Asians.

The inclusion of maternal education and paternal education, marital status, type of insurance, and neighborhood median income demonstrated varying degrees of socio-economic influence. Maternal age and maternal education confounded the relationship between PAH and Hispanic women. More educated women may have also been older. After multivariate logistic regression there was no association between advanced education and PAH in the Hispanic/Mexican exposure group. Paternal education, but not maternal education, explained some of the difference in PAH among Asians, especially Asian Indian and Chinese immigrants. More than 50% of Chinese and Indian fathers had graduate degrees. This high incidence of advanced education compared to U.S. born Asian fathers (20.5%) may have allowed illustration of socio-economic influence on hypertensive disorders of pregnancy. Chinese and Indian women also had advanced education as compared to U.S. born Women, but there was no confounding between maternal education and PAH.

This study illustrated disproportionate PAH risk for immigrants within the same exposure groups. This is illustrated in the “Black” cohort. This analysis depicts a disparate relationship between Somali immigrants and PAH versus Ethiopian immigrants and PAH. Very little of the decreased risk for PAH in Ethiopians looks to be associated measured risk factors or markers of SES. Most of the decreased risk is attributable to unmeasured factors of Ethiopian immigrants. On the other hand, the decreased rate of pregnancy associated hypertension in Somali immigrants as compared to U.S. born African Americans may be entirely attributed to maternal age, pre-pregnancy BMI, parity, and a history of chronic

hypertension. The Asian exposure group also depicted inconsistent PAH risk in the various immigrant groups. Unmeasured characteristics intrinsic to immigrants from these countries accounted for various proportions of the difference in PAH risk as compared to U.S. born Asians. This difference in confounding was found for the Hispanic and White exposure groups as well.

Unequal confounding leads to the question: what unmeasured characteristics of U.S. immigrants account for varying degrees of the decreased risk for developing pregnancy associated hypertension? Unmeasured characteristics that could account for decreased risk of PAH may be related to nutrition, exercise, or psychological stress. Maternal diets have been shown to be related to hypertensive disorders.[29,30] Psychological stressors are also associated with hypertensive disorders of pregnancy. [31] In the U.S., nutrition and exercise are related to socio-economic factors, wealthier neighborhoods are more likely to have access to fresh foods, and to have safer neighborhoods amenable to walking and convenient exercise.[32] This study attempted to account for socio-economic risk factors including adjustment for median neighborhood incomes. There was a non-statistically significant trend for increased PAH for women who lived in neighborhoods with lower median incomes. However, there can be more nebulous cultural associations of nutrition and exercise that are not measurable.

Culture differences may also affect psychologic stress that may confound the relationship between a person's country of origin and hypertensive disorders of pregnancy. Adjustment for socio-economic risk factors could relate to some psychological stress, and there are differences between the various countries of origin. Increasing *paternal* education was associated with decreased PAH for Asian and White women. Paternal education may be associated with increased access to healthier nutrition, exercise, and decreased psychological stress for Asian and White women. Increasing paternal education may lead to a better paying job, and improve finances so pregnant women have improved access for good nutrition, exercise, and physical well-being. Improved education of fathers leads to improved compliance with obstetric medical care -- especially in a culture in which men take a more active role in the obstetric care of their partners. Increased paternal education may lead to less psychological stress on the pregnant mother if she is not the primary breadwinner in the family and can afford to take time off from work to take care of herself and her pregnancy. The Hispanic population differed from the other populations in that

PAH risk was confounded by insurance type and maternal education. The unmeasured immigrant characteristics that account for differences in PAH (as compared to U.S. born women) may be how people from different cultures respond to risk factors. Each immigrant group may respond to different risk factors with diverse amounts of psychological stress, nutritional stress, and physical wellbeing.

This study evaluated PAH risk in immigrants from ten countries. This broad approach discovered similarities in immigrant groups from dissimilar geopolitical areas. There were essentially three groups of immigrants: those with much lower risk of PAH, those who had slightly lower risk of PAH that approached that of U.S. born women and those with very similar risk of PAH compared to U.S. born women of similar race. Ethiopians, Chinese, and Vietnamese had much lower risk of PAH compared to racially similar U.S. born women. Mexicans, Koreans, Asian Indians, and Russians had PAH risk approaching that of U.S. born women of similar race. Ukrainian and Somali women had similar PAH risk as their racially similar U.S. born control. Future studies could explore characteristics particular to these groups of immigrants.

Evaluation of the differences in pregnancy associated hypertension in immigrant groups could guide clinical practices. Successful global health interventions have been tested in underserved areas of the United States.[33] This study shows that immigrant women from India, Korea and Russia approaches the risk of U.S. born women of similar racial backgrounds, and women from Somalia and Ukraine have a similar risk of developing pregnancy associated hypertension as U.S. born women of similar race. Women from Somalia and Ukraine are more likely to be refugees than women from the other immigrant countries studied. African American U.S. born women have similar risk of PAH as Somali refugee women. White U.S. born women have similar risk of PAH as women from the Ukraine, another country in conflict. It seems reasonable to expand testing successful global health interventions beyond underserved areas. In addition, crude analysis revealed a decreased risk for PAH in these refugee women. Multivariate logistic regression adjusted for confounders. U.S. born women could strive to match risk factor characteristics of immigrant women. If U.S. born women had the same rates as Somali or

Ukrainian women of pre-pregnancy BMI, weight gain in pregnancy and maternal age at birth, might the U.S. born rate of PAH decrease?

Strengths of this population based study include its large population size, vast geopolitical spectrum, and the ability to adjust for multiple risk factors and potential confounders. The broad approach identified common characteristics that were associated with PAH in immigrants from various countries and the U.S. It also revealed inconsistencies across immigrant groups. The linked data set increased the sensitivity of identifying PAH cases.

Limitations of the study are linked to its retrospective design. It uses previously completed hospital discharge coding and birth certificates. The study relies on coders and informatics to accurately input hospital discharge information, and on individuals to accurately complete birth certificate records. This study evaluates U.S. immigrants from different countries, and as such should not be interpreted to represent all citizens from respective countries. The characteristics in this study represent characteristics of U.S. immigrants.

The incidence of pregnancy associated hypertension during this ten year period is higher across all racial exposure groups than most previously reported rates noted in literature reviews. We found the incidence of PAH in US born blacks was 11.2%, U.S. born White women was 9.9%, U.S. born Asians was 7.8%, and U.S. born Hispanics was 8.7%. This is in contrast with commonly reported rates of pre-eclampsia: African-Americans around 8.5%, followed by Hispanics ~6.2%, White/Caucasians ~5.5%, and Asian-Americans ~3-4%[20,23]. We combined all hypertensive disorders of pregnancy into one variable. Previous studies have stratified hypertensive disorders by gestational hypertension, pre-eclampsia, and eclampsia. The previously cited studies collected data from earlier time periods, and an April 2017 USPTS pre-eclampsia screening recommendation documents an increasing rate of pre-eclampsia in the last 10 years.[3]

In conclusion, this study confirms the healthy immigrant effect and a decreased risk for developing pregnancy associated hypertension for immigrants from China, Ethiopia, Vietnam, Mexico, India, Korea, and Russia as compared to their racially similar U.S. born controls. Women from Somalia and the

Ukraine have similar odds of developing pregnancy associated hypertension as compared to racially similar U.S. born women. Filipina women have higher odds of developing pregnancy associated hypertension. Known PAH risk factors affect immigrants from diverse countries in varying degrees. Developing risk assessments based on immigrant status versus U.S. born status may be an appropriate clinical strategy to identify women at risk for developing pregnancy associated hypertension.

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TABLES

Table 1A: Risk Factor Characteristics of Immigrants from Eastern African countries and U.S. Born African Americans

Maternal Risk Factors						
Risk Factor Variable	US Born Black n=16,895		Born in Ethiopia n=2460		Born in Somalia n= 2237	
Maternal age	n	%	n	%	n	%
< 20 years old	2,626	15.5	28	1.1	64	2.9
20-24 years	5,523	32.7	246	10.0	492	22.0
25-29 years	4,285	25.4	695	28.3	719	32.1
30-34 years	2,735	16.2	838	34.1	512	22.9
35-39 years	1,351	8.0	518	21.1	322	14.4
>40 year old	383	2.3	134	5.5	132	5.9
Weight Gain in Pregnancy						
<15 pounds	2,925	17.3	339	13.8	706	31.6
15-24 pounds	2,951	17.5	468	19.0	519	23.2
25-34 pounds	3,560	21.1	593	24.1	361	16.1
35-50 pounds	3,629	21.5	523	21.3	245	11.0
>50 pounds	1674	9.9	117	4.8	75	3.4
PrePregnancy BMI						
Underweight BMI < 18	227	1.3	74	3.0	68	3.0
normal weight	5,309	31.4	1,104	44.9	706	31.6
overweight	3,890	23.0	558	22.7	564	25.2
obese BMI 30-40	3,986	23.6	222	9.0	404	18.1
severely obese BMI>40	1,396	8.3	9	0.4	40	1.8
Smoking during Pregnancy						
nonsmoker	14,315	84.7	2,401	97.6	2,196	98.2
< 1/2 pack a day	1,330	7.9	6	0.2	6	0.3
1 pack per day	593	3.5	7	0.3	2	0.1
>1 pack per day	657	3.9	46	1.9	33	1.5
Parity						
nulliparous	8,131	48.1	1,160	47.2	609	27.2
multiparous	8,245	48.8	1,227	49.9	1,602	71.6
Chronic Hypertension						
no hx Chronic HTN	16,212	96.0	2,422	98.5	2,198	98.3
Hx Chronic HTN	683	4.0	38	1.5	39	1.7
Diabetes						
no diabetes	15,608	92.4	2,214	90.0	2,023	90.4

Pregestational DM	163	1.0	27	1.1	34	1.5
Gestational DM	727	4.3	171	7.0	151	6.8
Singleton or Twins+						
singleton	16,363	96.9	2,381	96.8	2,184	97.6
multifetal	532	3.2	79	3.2	53	2.4
Socio-Economic Risk Factors						
Maternal Education						
less than High School diploma	3,119	18.5	518	21.1	976	43.6
earned High School diploma	5,221	30.9	886	36.0	681	30.4
some college	6,442	38.1	737	30.0	348	15.6
graduated from 4-year college	1,303	7.7	179	7.3	72	3.2
graduate school	613	3.6	49	2.0	15	0.7
Paternal Education						
less than High School diploma	1,372	8.1	276	11.2	567	25.4
earned High School diploma	3,646	21.6	533	21.7	663	29.6
some college	3,589	21.2	693	28.2	472	21.1
graduated from 4-year college	1,026	6.1	266	10.8	150	6.7
graduate school	394	2.3	178	7.2	44	2.0
Marital Status						
married	5,122	30.3	1,619	65.8	1,815	81.1
not married	11,711	69.3	835	33.9	409	18.3
Primary Payer Code						
Medicaid	9,072	53.7	1,390	56.5	1,809	80.9
Private Insurance or self-pay	5,416	32.1	761	30.9	295	13.2
Indian Health Services	11	0.1	3	0.1	2	0.1
Gov't insurance	1,839	10.9	86	3.5	47	2.1
other	13	0.1	1	0.0	1	0.0
Income Category						
< $35Kper year (25%ile)	4,432	26.2	541	22.0	478	21.4
$35K - $44K per year (up to 50%ile)	5,657	33.5	1,037	42.2	1,213	54.2
$44K - $56K per year (up to 75%ile)	3,887	23.0	525	21.3	381	17.0
> $56K per year (>75%ile)	2,693	15.9	349	14.2	153	6.8

Table 2A: PAH Crude Analysis for Immigrants from Eastern African countries and U.S. Born African Americans

Risk of Pregnancy Associated Hypertension (PAH) in women born in Ethiopia and Somalia compared to U.S. born African Americans				
total sample size= 21,592		**U.S. Born Black**	**Ethiopian**	**Somali**
		n=16,895	n=2460	n= 2237
Pregnancy Associated Hypertension	n	1,899	175	172
	%	11.2	7.1	7.7
Risk of PAH as compared to U.S. born African Americans				
Odds Ratio		(ref)	0.60 (0.51, 0.71)	0.66 (0.56, 0.77)

Table 3A: Multivariate Model for Immigrants from Eastern African countries and U.S. Born African Americans

Multivariate Analysis			
total sample size= 17,889	**OR**	**CI**	
U.S. African Americans	**1.00**	**(ref)**	
Ethiopia	0.72	0.59	0.88
Somalia	1.04	0.86	1.26
	OR	**CI**	
maternal age			
<20 years old	0.87	0.73	1.04
20-24 yrs	0.88	0.77	1.02
25-29 yrs	reference		
30-34 yrs	1.23	1.06	1.43
35-39 yrs	1.11	0.92	1.34
>40 yrs	1.28	0.95	1.72
Weight gain in pregnancy			
<15 pounds	0.77	0.66	0.90
15-24 pounds	0.80	0.68	0.93
25-34 pounds	reference		
35-50 pounds	1.22	1.06	1.41
>50 pounds	1.47	1.23	1.74
Prepregnancy BMI			
Underweight BMI < 18	1.13	0.76	1.68
normal weight	reference		
overweight	1.38	1.21	1.58
obese BMI 30-40	2.06	1.80	2.35
severely obese BMI>40	3.01	2.49	3.63

Parity			
nulliparous	reference		
multiparous	0.49	0.44	0.54
Chronic Hypertension			
no hx Chronic HTN	reference		
Hx Chronic HTN	3.21	2.65	3.88

Table 1B: Risk Factor Characteristics for Immigrants from Eastern European countries and U.S. born Whites

Maternal Risk Factors						
Risk Factor Variable	US Born White n= 92345		Born in Ukraine n= 5819		Born in Russia n= 3416	
Maternal age	n	%	n	%	n	%
< 20 years old	2,622	15.5	28	1.1	64	2.9
20-24 years	5,521	32.7	246	10.0	491	22.0
25-29 years	4,280	25.3	695	28.3	718	32.1
30-34 years	2,734	16.2	838	34.1	511	22.8
35-39 years	1,350	8.0	518	21.1	321	14.4
>40 year old	383	2.3	134	5.5	132	5.9
Weight Gain in Pregnancy						
<15 pounds	10,148	11.0	670	11.5	304	8.9
15-24 pounds	15,182	16.4	1189	20.4	572	16.7
25-34 pounds	24,612	26.7	1689	29.0	1033	30.2
35-50 pounds	25,452	27.6	1426	24.5	968	28.3
>50 pounds	9612	10.4	385	6.6	258	7.6
PrePregnancy BMI						
Underweight BMI < 18	1,483	1.6	142	2.4	115	3.4
normal weight	41,043	44.5	3,042	52.3	1,973	57.8
overweight	21,285	23.1	1,285	22.1	634	18.6
obese BMI 30-40	16,891	18.3	758	13.0	333	9.8
severely obese BMI>40	4,054	4.4	70	1.2	24	0.7
Smoking during Pregnancy						
nonsmoker	79,430	86.0	5,769	99.1	3,352	98.1
< 1/2 pack a day	4,942	5.4	22	0.4	23	0.7
1 pack per day	4,847	5.3	18	0.3	24	0.7
>1 pack per day	3,125	3.4	10	0.2	17	0.5
Parity						
nulliparous	41,081	44.5	1,949	33.5	1,386	40.6
multiparous	49,797	53.9	3,818	65.6	1,990	58.3
Chronic Hypertension						

no hx Chronic HTN	90,444	97.9	5,733	98.5	3,360	98.4
Hx Chronic HTN	1,901	2.1	86	1.5	56	1.6
Diabetes						
no diabetes	85,779	92.9	5,375	92.4	3,121	91.4
Pregestational DM	632	0.7	15	0.3	6	0.2
Gestational DM	4,621	5.0	362	6.2	228	6.7
Singleton or Twins+						
singleton	89,137	96.5	5,719	98.3	3,318	97.1
multifetal	3,208	3.5	100	1.7	98	2.9
Socio-Economic Risk Factors						
Maternal Education	n	%	n	%	n	%
less than High School diploma	9,532	10.3	487	8.4	184	5.4
earned High School diploma	21,107	22.9	2,223	38.2	830	24.3
some college	32,245	34.9	2,221	38.2	1,165	34.1
graduated from 4-year college	19,449	21.1	550	9.5	604	17.7
graduate school	9,479	10.3	267	4.6	598	17.5
Paternal Education						
less than High School diploma	7,348	8.0	594	10.2	240	7.0
earned High School diploma	19,808	21.5	2,248	38.6	840	24.6
some college	26,281	28.5	1,942	33.4	1,049	30.7
graduated from 4-year college	17,705	19.2	523	9.0	514	15.1
graduate school	8,267	9.0	300	5.2	598	17.5
Marital Status						
married	63,044	68.3	5,618	96.6	3,143	92.0
not married	29,153	31.6	200	3.4	272	8.0
Primary Payer Code						
Medicaid	27,930	30.3	3,129	53.8	1,447	42.4
Private Insurance or self-pay	56,766	61.5	2,086	35.9	1,708	50.0
Indian Health Services	35	0.0	0	0.0	0	0.0
Gov't insurance	5,335	5.8	491	8.4	177	5.2
Income Category						
< $35Kper year (25%ile)	17,466	18.9	969	16.7	440	12.9
$35K - $44K per year (up to 50%ile)	22,646	24.5	1,634	28.1	816	23.9
$44K - $56K per year (up to 75%ile)	22,262	24.1	1,290	22.2	820	24.0
> $56K per year (>75%ile)	27,328	29.6	1,854	31.9	1,284	37.6

Table 2B: PAH Crude Analysis Results for Immigrants from Eastern European countries and U.S. born Whites

Risk of Pregnancy Associated Hypertension (PAH) in women born in Ukraine and

Russia compared to U.S. born Whites				
		U.S. born	Ukrainian	Russian
total sample size=101,580		n=92,345	n=5,819	n= 3,416
Pregnancy Associated Hypertension	n	9,177	398	234
	%	9.9	6.8	6.9
Risk of PAH as compared to U.S. born Whites				
Odds Ratio (CI)		(ref)	0.67 (0.58, 0.76)	0.67 (0.58, 0.76)

Table 3C: Multivariate Model for Immigrants from Eastern European countries and U.S. born Whites

Multivariate Tables			
	Multivariate		
sample size = 78,598	**OR**	**CI**	
U.S. born White	**1.00**	**(ref)**	
Ukrainian	0.92	0.82	1.03
Russian	0.86	0.73	1.00
Risk Factor Variable			
Maternal age	**OR**	**CI**	
< 20 years old	0.82	0.73	0.94
20-24 years	0.92	0.85	0.98
25-29 years	reference		
30-34 years	1.07	1.00	1.15
35-39 years	1.19	1.10	1.30
>40 year old	1.64	1.44	1.87
Weight Gain in Pregnancy			
<15 pounds	0.72	0.66	0.79
15-24 pounds	0.91	0.84	0.98
25-34 pounds	reference		
35-50 pounds	1.34	1.26	1.44
>50 pounds	2.39	2.21	2.58
PrePregnancy BMI			
Underweight BMI < 18	0.73	0.56	0.94
normal weight	reference		
overweight	1.72	1.61	1.83
obese BMI 30-40	3.19	2.98	3.40
severely obese BMI>40	5.98	5.39	6.63
Parity			
nulliparous	reference		
multiparous	0.44	0.41	0.46

Diabetes			
no diabetes	reference		
Pregestational DM	2.16	1.73	2.70
Gestational DM	1.73	1.59	1.89
Paternal Education			
less than High School diploma	reference		
earned High School diploma	1.07	0.98	1.18
some college	1.10	1.00	1.20
graduated from 4-year college	0.98	0.88	1.09
graduate school	0.86	0.76	0.98

Table 1C: Risk Factor Characteristics for Immigrant Women born in Asian countries and U.S. born Asians

Maternal Risk Factors												
country of origin	US Born Asian		China		Philippines		India		Korea		Vietnam	
Risk Factor Variable	n=	5,205	n=	3,612	n=	5,490	n=	7,493	n=	3,621	n=	5,803
maternal age	n	%	n	%	n	%	n	%	n	%	n	%
<20 years old	250	4.8	10	0.3	106	1.9	12	0.2	27	0.8	31	0.5
20-24 yrs	725	13.9	108	3.0	696	12.7	528	7.1	169	4.7	473	8.2
25-29 yrs	1,269	24.4	797	22.1	1,400	25.5	3,122	41.7	749	20.7	1,489	25.7
30-34 yrs	1,837	35.3	1,498	41.5	1,752	31.9	2,952	39.4	1,530	42.3	2,085	35.9
35-39 yrs	929	17.9	970	26.9	1,180	21.5	770	10.3	948	26.2	1,405	24.2
>40 yrs	192	3.7	229	6.3	355	6.5	106	1.4	198	5.5	320	5.5
Weight gain in pregnancy												
<15 pounds	526	10.1	218	6.0	642	11.7	665	8.9	312	8.6	519	8.9
15-24 pounds	947	18.2	604	16.7	1,126	20.5	1,608	21.5	698	19.3	1,217	21.0
25-34 pounds	1,593	30.6	1,324	36.7	1,613	29.4	2,330	31.1	1,220	33.7	1,905	32.8
35-50 pounds	1,354	26.0	964	26.7	1,267	23.1	1,737	23.2	842	23.3	1,324	22.8
>50 pounds	294	5.7	136	3.8	255	4.6	302	4.0	149	4.1	157	2.7
Prepregnancy BMI												
Underweight BMI < 18	102	2.0	252	7.0	199	3.6	213	2.8	178	4.9	437	7.5
normal weight	2,830	54.4	2,601	72.0	3,045	55.5	4,205	56.1	2,250	62.1	3,897	67.2
overweight	1,063	20.4	296	8.2	1,127	20.5	1,722	23.0	565	15.6	613	10.6
obese BMI 30-40	637	12.2	39	1.1	496	9.0	472	6.3	192	5.3	131	2.3
severely obese BMI>40	69	1.3	0	0.0	27	0.5	20	0.3	17	0.5	2	0.0

Smoking during Pregnancy												
nonsmoker	4,919	94.5	3,581	99.1	5,284	96.3	7,467	99.7	3,480	96.1	5,704	98.3
< 1/2 pack a day	126	2.4	1	0.0	87	1.6	4	0.1	63	1.7	15	0.3
1 pack per day	63	1.2	2	0.1	39	0.7	3	0.0	38	1.1	4	0.1
>1 pack per day	97	1.9	28	0.8	80	1.5	19	0.3	40	1.1	80	1.4
Parity												
nulliparous	2,918	56.1	2,043	56.6	2,535	46.2	4,412	58.9	1,823	50.4	2,526	43.5
multiparous	2,196	42.0	1,511	41.8	2,864	52.2	2,972	39.7	1,718	47.5	3,167	54.6
Chronic Hypertension												
no hx Chronic HTN	5,083	97.7	3,595	99.5	5,353	97.5	7,426	99.1	3,565	98.5	5,766	99.4
Hx Chronic HTN	122	2.3	17	0.5	137	2.5	67	0.9	56	1.6	37	0.6
Diabetes												
no diabetes	4,647	89.3	3,092	85.6	4,694	85.5	6,384	85.2	3,271	90.3	4,941	85.5
pregestational DM	42	0.8	11	0.3	59	1.1	63	0.8	16	0.4	28	0.5
gestational DM	393	7.6	458	12.7	617	11.2	999	13.3	270	7.5	661	11.4
Singleton or Twins+												
singleton	5,065	97.3	3,523	98.1	5,388	98.1	7,220	96.4	3,516	97.1	5,686	98.0
multifetal	140	2.7	89	2.5	102	1.9	273	3.6	105	2.9	117	2.0
Socio-Economic Risk Factors												
Maternal Education	n	%	n	%	n	%	n	%	n	%	n	%
less than High School diploma	267	5.1	136	3.8	214	3.9	166	2.2	54	1.5	1,353	23.3
earned High School diploma	589	11.3	404	11.2	931	17.0	444	5.9	294	8.1	1,262	21.8
some college	1,392	26.7	504	14.0	1,952	35.6	513	6.9	982	27.1	1,456	25.1
graduated from 4-year college	1,788	34.4	1,002	27.7	2,004	36.5	2,920	39.0	1,570	43.4	1,234	21.3
graduate school	1,144	22.0	1,537	42.6	338	6.2	3,407	45.5	672	18.6	379	6.5
Paternal Education												
less than High School diploma	204	3.9	132	3.7	914	3.5	151	2.0	44	1.2	959	16.5
earned High School diploma	657	12.6	363	10.1	1,114	20.3	454	6.1	272	7.5	978	16.9
some college	1,357	26.1	346	9.6	2,061	37.5	378	5.0	839	23.2	1,476	25.4

graduated from 4-year college	1,448	27.8	818	22.7	1,296	23.6	2,523	33.7	1,354	37.4	1,299	22.4
graduate school	1,066	20.5	1,854	51.3	348	6.3	3,872	51.7	942	26.0	461	7.9
Marital Status												
married	3,938	75.7	3,415	94.6	4,344	79.1	7,366	98.3	3,283	90.7	4,823	83.1
not married	1,266	24.3	196	5.4	1,140	20.8	125	1.7	338	9.3	971	16.7
Primary Payer Code												
Medicaid	973	18.7	678	18.8	1,299	23.7	894	11.9	815	22.5	1,921	33.1
Private Insurance or self-pay	3,789	72.8	2,757	76.3	3,589	65.4	6,295	84.0	2,532	69.9	3,286	56.6
Indian Health Services	4	0.1	0	0.0	2	0.0	0	0.0	0	0.0	0	0.0
Gov't insurance	251	4.8	53	1.5	387	7.1	90	1.2	140	3.9	285	4.9
Income Category												
< $35Kper year (25%ile)	506	9.7	399	11.1	710	12.9	319	4.3	352	9.7	622	10.7
$35K - $44K per year (up to 50%ile)	1,067	20.5	585	16.2	1,619	29.5	797	10.6	680	18.8	1,849	31.9
$44K - $56K per year (up to 75%ile)	1,365	26.2	680	18.8	1,479	26.9	2,384	31.8	822	22.7	1,614	27.8
> $56K per year (>75%ile)	2,191	42.1	1,919	53.1	1,613	29.4	3,938	52.6	1,717	47.4	1,652	28.5

Table 2C: PAH Crude Analysis Results for Immigrant Women born in Asian countries and U.S. born Asians

Risk of Pregnancy Associated Hypertension (PAH) in Women born in Asian countries compared to U.S. born Asian Women							
			immigrants from…				
		US born	China	Philippines	India	Korea	Vietnam
total sample size=31,224		n=5205	n=3612	n=5490	n=7493	n=3621	n=5803
PAH	n=	404	110	513	388	193	214
	%	7.8	3.1	9.3	5.2	5.3	3.7
PAH in women born in Asian countries as compared to US born Asian Women							
Odds Ratio (n=31,224)		1.00	0.37	1.22	0.65	0.67	0.46
(95% Confidence Intervals)		(ref)	(0.30, 0.46)	(1.07, 1.40)	(0.56, 0.75)	(0.56, 0.80)	(0.38, 0.54)

Table 2C1: Proportion PAH for U.S. born Asians

Proportion of Pregnancy Associated Hypertension (PAH) in U.S. born Asian Women, by ethnic origin							
			U.S. born, separated by ethnic identity				
		All Asian	Chinese	Filipino	Asian Indian	Korean	Vietnamese
		n=5205	n=1,221	n=2,250	n=537	n=664	n=533
PAH	n=	404	87	217	34	41	25
	%	7.8	7.1	9.6	6.3	6.2	4.7

Table 3C: Multivariate Model for Immigrant Women born in Asian countries and U.S. born Asians

Multivariate Analysis			
sample size =25,096	**OR**	**CI**	
U.S. born	**1.00**	**(ref)**	
China	0.51	(0.40,	0.65)
Philippines	1.34	(1.14,	1.57)
India	0.84	(0.70,	1.00)
Korea	0.78	(0.64,	0.96)
Vietnam	0.58	(0.47,	0.72)
Risk Variables			
maternal age	OR	CI	
<20 years old	0.55	0.30	1.01
20-24 yrs	0.87	0.69	1.09
25-29 yrs	reference		
30-34 yrs	1.19	1.04	1.38
35-39 yrs	1.64	1.39	1.93
>40 yrs	2.54	2.00	3.21
Weight gain in pregnancy			
<15 pounds	0.90	0.74	1.10
15-24 pounds	0.92	0.79	1.08
25-34 pounds	reference		
35-50 pounds	1.38	1.20	1.59
>50 pounds	2.72	2.21	3.35
Prepregnancy BMI			
Underweight BMI < 18	0.64	0.44	0.91
normal weight	reference		
overweight	1.89	1.65	2.15
obese BMI 30-40	2.58	2.15	3.09

severely obese BMI>40	5.12	3.09	8.49
Parity			
nulliparous	reference		
multiparous	0.48	0.42	0.54
Chronic Hypertension			
no hx Chronic HTN	reference		
Hx Chronic HTN	4.99	3.91	6.36
Diabetes			
no diabetes	reference		
pregestational DM	2.22	1.46	3.38
gestational DM	1.41	1.21	1.64
Paternal Education			
less than High School diploma	reference		
earned High School diploma	0.95	0.72	1.26
some college	0.87	0.66	1.14
graduated from 4-year college	0.73	0.56	0.96
graduate school	0.67	0.50	0.89

Table 4C: Ethnic backgrounds of U.S. born Asians

U.S.born Asian Ethnic Origins vs Asian Immigrant Country of Origin			
	U.S. born	Immigrants	total
1= White	0	628	628
2= Black	0	67	67
3= Native American	0	10	10
4= Chinese	1221	3874	5095
5= Japanese	0	6	6
6= Filipino	2250	4916	7166
8= Other Asian	0	627	627
9= Hispanic	0	17	17
11= Asian Indian	538	7338	7876
12= Korean	665	3301	3966
14= Vietnamese	534	5153	5687
15= Guamanian	0	11	11

Table 1D: Risk Factor Characteristics for Mexican born immigrants and U.S. born Hispanic Women

Maternal Risk Factors				
Country of Origin: (total n=66,528)	US born Hispanic		born in Mexico	
Variable	n=	16,632	n=	49,896
maternal age	n	%	n	%
<20 years old	4,503	27.1	4,936	9.9
20-24 yrs	5,527	33.2	12,578	25.2
25-29 yrs	3,619	21.8	14,144	28.4
30-34 yrs	1,953	11.7	11,132	22.3
35-39 yrs	849	5.1	5,695	11.4
>40 yrs	180	1.1	1,401	2.8
Weight gain in pregnancy				
<15 pounds	2,769	18.3	9,131	20.4
15-24 pounds	3,396	22.5	12,935	28.9
25-34 pounds	4,078	27.0	12,708	28.4
35-50 pounds	3,479	23.0	8,118	18.1
>50 pounds	1,408	9.3	1,865	4.2
Prepregnancy BMI				
Underweight BMI < 18	249	1.7	639	1.5
normal weight	5,864	39.0	17,443	40.8
overweight	4,159	27.7	14,441	33.8
obese BMI 30-40	3,841	25.5	9,179	21.5
severely obese BMI>40	927	6.2	1,017	2.4
Smoking during Pregnancy				
nonsmoker	15,618	94.5	49,310	99.3
< 1/2 pack a day	466	2.8	230	0.5
1 pack per day	240	1.5	60	0.1
>1 pack per day	205	1.2	41	0.1
Parity				
nulliparous	6,878	42.2	12,238	24.9
multiparous	9,430	57.8	36,932	75.1
Chronic Hypertension				
no hx Chronic HTN	16,399	98.6	49,451	99.1
Hx Chronic HTN	233	1.4	445	0.9
Diabetes				
no diabetes	15,471	93.8	44,868	90.8
pregestational DM	155	0.9	506	1.0
Gestational diabetes	869	5.2	4,035	8.1
Singleton or Twins+				
singleton	16,318	98.1	49,009	98.2
multifetal	314	1.9	887	1.8
Socio-Economic Risk Factors				
Maternal Education	n	%	n	%
less than High School diploma	5,867	35.6	30,384	63.2
earned High School diploma	5,351	32.4	11,913	24.8
some college	4,127	25.0	4,362	9.1
graduated from 4-year college	862	5.2	1,154	2.4
graduate school	296	1.8	276	0.6

Paternal Education				
less than High School diploma	4,460	26.8	25,944	52
earned High School diploma	4,014	24.1	8,818	17.7
some college	2,483	14.9	3,341	6.7
graduated from 4-year college	710	4.3	889	1.8
graduate school	253	1.5	361	0.7
Marital Status				
married	6,617	40.0	26,018	52.4
not married	9,940	60.0	23,642	47.6
Primary Payer Code				
Medicaid	10,647	65.2	43,734	89.1
Private Insurance or self-pay	4,522	27.7	4,543	9.3
Indian Health Services	7	0.0	11	0.0
Gov't insurance	1,145	7.0	804	1.6
Income Category				
< $35Kper year (25%ile)	7,291	44.9	21,890	45.3
$35K - $44K per year (up to 50%ile)	4,608	28.4	15,350	31.7
$44K - $56K per year (up to 75%ile)	2,562	15.8	6,848	14.2
> $56K per year (>75%ile)	1,766	10.9	4,283	8.9

Table 2D: PAH Crude Analysis Results for Mexican born immigrants and U.S. born Hispanic Women

Risk of Pregnancy Associated Hypertension (PAH) in Women born in Mexico compared to U.S. born Hispanic Women			
		U.S. born Hispanic	**born in Mexico**
total sample size= 66,528		n= 16632	n= 49896
PAH	n	1,446	2966
	%	8.7	6.0
Risk of PAH in Mexican as compared to U.S. born Hispanic Women			
Crude Odds Ratio (CI)		1.00 (ref)	0.66 (0.62, 0.71)

Table 3D: Multivariate Model for Mexican born immigrants and U.S. born Hispanic Women

Multivariate Analysis					
sample size = 54,315			**OR**	**CI**	
U.S. born Hispanic	**OR**	**CI**	1.00	(REF)	
Mexico:	0.66	0.62, 0.71	0.87	0.80	0.95
Risk Factor Variable					
maternal age					
<20 years old			1.08	0.95	1.23
20-24 yrs			1.05	0.95	1.17
25-29 yrs			reference		

30-34 yrs		1.22	1.10	1.37
35-39 yrs		1.75	1.54	1.98
>40 yrs		2.26	1.86	2.74
Weight gain in pregnancy				
<15 pounds		0.71	0.63	0.79
15-24 pounds		0.84	0.76	0.93
25-34 pounds		reference		
35-50 pounds		1.35	1.22	1.48
>50 pounds		2.15	1.89	2.45
Prepregnancy BMI				
Underweight BMI < 18		0.64	0.45	0.93
normal weight		reference		
overweight		1.55	1.42	1.69
obese BMI 30-40		2.44	2.23	2.68
severely obese BMI>40		4.75	4.08	5.53
Parity				
nulliparous		reference		
multiparous		0.40	0.37	0.43
Diabetes				
no diabetes		reference		
pregestational DM		2.54	2.01	3.23
gestational diabetes		1.87	1.68	2.08
Maternal Education				
less than High School diploma		reference		
earned High School diploma		1.02	0.94	1.10
some college		0.98	0.88	1.10
graduated from 4-year college		0.73	0.59	0.91
graduate school		1.08	0.78	1.50
Primary Payer Code				
Medicaid		reference		
Private Insurance or self-pay		1.05	0.95	1.17
Indian Health Services		1.06	0.13	8.47
Gov't insurance		1.01	0.83	1.21