SOCIOCULTURAL FACTORS THAT AFFECT PREGNANCY OUTCOMES IN TWO DISSIMILAR IMMIGRANT GROUPS IN THE UNITED STATES

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Objective To compare perinatal risks and outcomes in foreign- and U.S.-born Asian-Indian and Mexican women.

Study design We evaluated 6.4 million U.S. vital records for births during 1995–2000 to white, foreign- and U.S.-born Asian-Indian and Mexican women. Risks and outcomes were compared by use of $\chi 2$ and logistic regression.

Results With the exception of increased teen pregnancy and tobacco use, the favorable sociodemographic profile and increased rate of adverse outcomes seen in foreign-born Asian Indians persisted in their U.S.-born counterparts. In contrast, foreign-born Mexicans had an adverse sociodemographic profile but a low incidence of low birth weight (LBW), whereas U.S.-born Mexicans had an improved sociodemographic profile and increased LBW, prematurity and neonatal death.

Conclusions Perinatal outcomes deteriorate in U.S.-born Mexican women. In contrast, the paradoxically increased incidence of LBW persists in U.S.-born Asian-Indian women. Further research is needed to identify the social and biologic determinants of perinatal outcome. ***(J Pediatr 2006;148:341-6)***

The population of the United States is becoming progressively more diverse, with an increase in the number of individuals of Hispanic and Asian origin.[1,2] Given the rapidly diversifying population and influx of foreign-born women in the U.S., assessment of the risk factors associated with poor perinatal outcomes in these populations is important. Foreign-born women in several ethnic groups had significantly better perinatal outcomes compared with their U.S.-born counterparts.[3-7] Foreign-born Mexican women in particular, despite being at greater risk because of having a lower average socioeconomic status, have paradoxically good perinatal outcomes when compared with U.S.-born non-Hispanic white women (referred to as white).[4,8–12] Unfortunately, these favorable outcomes are not observed in the subsequent generation of U.S.-born Mexican-American women, who have poorer perinatal outcomes than foreign-born Mexican women.[13,14] With a California birth cohort from 1995–1997, we have shown that in contrast to the epidemiologic paradox observed in Mexican-American women, foreign-born Asian-Indian women, despite having a low-risk profile, have a higher incidence of small for gestational age (SGA) and low birth weight (LBW) infants.[15] The California cohort was not large enough to assess perinatal risks and outcomes in U.S.-born Asian-Indian women, and there are no studies comparing foreign-born with U.S.-born Asian-Indian women. SGA infants are known to be at increased risk for morbidity from hypoglycemia and intrauterine hypoxia and at increased risk for long-term morbidity from diabetes, hypertension, and coronary artery disease.[16-19] The incidence of non-insulin-dependent diabetes and coronary artery disease is known to be higher in South Asian populations in comparison to Europeans.[20-22] The increased incidence of SGA infants in Asian-Indian mothers, a population with a seemingly low-risk sociodemographic profile, provided us with an opportunity to explore further the social and acculturation factors that affect fetal growth. Increased understanding of the factors that affect fetal growth will help us in designing better methods of prevention of intrauterine growth restriction and in improving perinatal outcomes. The purpose of this study is to use a national birth cohort to examine the incidence rates of perinatal complications such as LBW and SGA infants among foreign- and U.S.-born Asian-Indian, and foreign- and U.S.-born Mexican women, and to identify any sociodemographic or health-related characteristics that might account for observed differences between these racial/ethnic groups.

METHODS

Information regarding 9.1 million singleton U.S. births from the 11 states that reported Asian-Indians as a separate category on the birth certificate for a 5-year period

LBW	Low birth weight	SGA	Small for gestational age
NMR	Neonatal mortality rate		

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spanning 1995–2000 was obtained from the Perinatal Mortality Data File, maintained by the Centers for Disease Control. These states included California, Hawaii, Illinois, New Jersey, New York, Texas, and Washington in 1995 and 1996; all of these states and Minnesota in 1997, Virginia in 1998, and Missouri and West Virginia in 1999 and 2000. Data with recorded place of birth was available for 6.4 million births to U.S.-born whites, U.S.-born and foreign-born Mexican, and U.S.-born and foreign-born Asian-Indians.

Sociodemographic characteristics consisted of maternal age (<19 years, 20-34 years, and >35 years), maternal education (<high school, high school, some college, and completion of college), and initiation of prenatal care (first, second, or third trimester). Insurance status and paternal education status were not available in the data set. Health-related characteristics included use of tobacco and alcohol during pregnancy, presence of perinatal complications (ie, anemia, preeclampsia, hypertension, diabetes, and placenta previa/abruption). The incidence rates of perinatal outcomes were determined for low birth weight (LBW; <2500 g); very low birth weight (<1500 g); small for gestational age (SGA; defined as a birth weight less than third percentile with a growth curve generated from infants born to white mothers in 1994),[23] preterm births (<37 completed weeks of gestation); fetal deaths per 1000 live births; neonatal deaths (death before 28 days of age per 1000 live births); and postneonatal deaths (28 days to 1 year).

Sociodemographic and health-related characteristics, the incidence of perinatal complications and outcomes were compared between the U.S- and foreign-born women in both ethnic groups, as well as between each ethnic group and the white reference group using χ^2 analyses. The white group has traditionally been used as a reference group because the largest number of U.S. births is in this population. Risk factors for LBW identified from the literature were examined in singleton live born infants with logistic regression analyses (SAS for Windows, Version 8; SAS Institute, Cary, NC). Separate models were run for each race/ethnicity/nationality grouping. Results are presented as odds ratios with 95% confidence intervals.

RESULTS

There were 6.4 million births to white (62.4%); foreign-born Asian Indian (1.2%); U.S.-born Asian Indian (0.07%); foreign-born Mexican (21.9%); and U.S.-born Mexican (14.5%) during 1995 to 2000. Of the excluded births, birth place was unknown in 81,276 (0.89%) white, 787 (0.01%) Asian Indian, 15,539 (0.17%) Mexican, and 23,303 (0.26%) black women. Another 871,624 (9.57%) infants were delivered by U.S.-born black women and 1,692,786 (18.58%) of the births were to either other Asian, non-Mexican Hispanic, or mothers of other races/ethnicity.

Table I shows the maternal sociodemographic and health-related characteristics for the 5 groups of women studied. Foreign- and U.S.-born Indian women have a favorable sociodemographic profile compared with white women, particularly for attaining a college education, completing high school, and having lower rates of teen pregnancy and substance use.

Consistent with prior studies, foreign-born Mexican women had a more adverse risk profile than white mothers, as evidenced by higher teen pregnancy rates, less access to first trimester prenatal care, and a higher percentage of mothers with less than a high school education ($P < .001$). In comparison to foreign-born, U.S-born Mexican mothers had a better sociodemographic risk profile with respect to increased access to prenatal care in the first trimester and a greater number of college graduates. However, the incidence of teen pregnancy, as well as alcohol and tobacco use, was higher in U.S.-born than in foreign-born Mexican women ($P < .001$).

Table I also shows the complications of pregnancy and labor in all 5 groups. The incidence of diabetes was much higher in foreign-born Indians compared with U.S.-born Indian women, and both groups had a higher incidence compared with white women. Hypertension and preeclampsia, conditions associated with intrauterine growth restriction, were lower in the Indian population.

Table II shows the birth outcomes for all groups. The only statistically significant differences between foreign- and U.S.-born Indian women was a 29-g increase in mean birth weight from 3174 to 3203 g ($P < .05$). In general, both Indian groups had a lower mean birth weight and a greater percentage of LBW and SGA infants compared with infants born to white women. Mortality rates were similar in foreign- and U.S.-born Indian women and similar when compared with the rates for white women. Analysis of birth weight–specific mortality rates showed that infants born to both foreign- and U.S.-born Asian-Indian mothers had a lower mortality rate in the 1500- to 2500-g category when compared with white women (Table II).

In contrast to the findings in the Asian-Indian population, foreign-born Mexican women had a lower postnatal mortality rate compared with white women. U.S-born Mexican women had a higher rate of prematurity, LBW, very low birth weight, SGA, neonatal mortality rate (NMR), and postnatal mortality rate compared with both foreign-born Mexican and white women.

Table III shows the results of the multiple logistic regressions of independent risk factors for LBW in singleton live births in each of the 5 groups. The relative importance of specific risk factors for LBW differed by both ethnicity and natality. Teenage pregnancy was more likely to result in a LBW infant in both foreign-born Indian and Mexican women than in other groups, whereas maternal age ≥35 years was more predictive of LBW in U.S.-born white women and in both foreign- and U.S.-born Mexican women. A less than high school maternal education was more predictive of LBW in U.S.-born Asian-Indian, Mexican, and white women but not in foreign-born women of either ethnic group. Later initiation of prenatal care was more predictive of LBW in U.S.-born than foreign-born Asian-Indian or Mexican

Table I. Selected characteristics and complications related to pregnancy and birth in U.S.-born non-hispanic white, U.S.- and foreign-born Asian-Indian, and U.S.- and foreign-born Mexican mothers — U.S. births, 1995–2000

Characteristic (%)	U.S.-born white (*n* = 4,005,671)	Foreign-born Asian-Indian (*n* = 76,618)	U.S.-born Asian-Indian (*n* = 4285)	Foreign-born Mexican (*n* = 1,408,797)	U.S.-born Mexican (*n* = 928,801)
Maternal age					
≤19 y	8.29	0.79*	4.36*†	11.49*	26.48*‡
≥35 y	16.53	11.05*	8.66*†	9.64*	6.04*‡
Maternal education					
≤High school	40.92	21.21*	24.83*†	87.95*	75.03*‡
≥College graduate	32.85	55.66*	52.42*†	3.11*	6.69*‡
Initiation of prenatal care					
1st trimester	86.52	84.39*	84.69*	70.31*	74.98*‡
3rd trimester	4.27	5.37*	5.27	9.41*	6.69*‡
Substance Use					
Alcohol use	0.88	0.09*	0.14*	0.10*	0.43*‡
Tobacco use	10.12	0.17*	1.52*†	0.35*	1.94*‡
Pregnancy/labor complications					
Hypertension	3.69	1.89*	2.33*	2.07*	3.05*‡
Pre-eclampsia	0.18	0.10*	0.07	0.13*	0.22*‡
Diabetes	2.52	6.17*	3.99*†	2.52	2.25*‡
Placenta previa	0.84	0.75	0.89	0.48*	0.55*‡
Anemia	2.02	1.75*	1.47	1.59*	2.02‡
Maternal fever	1.49	2.18*	1.77	1.25*	1.52‡

Data source: Centers for Disease Control, Birth Cohort File, 1995–2000.
Includes all U.S. births from states that reported births to Asian-Indian and Mexican women with a known birth weight > 500 g.
*Compared with U.S.-born non-Hispanic white mothers, χ^2 test, $P < .001$.
†Compared with foreign-born Indian-Asian Mothers, χ^2 test, $P < .001$.
‡Compared with foreign-born Mexican mothers, χ^2 test, $P < .001$.

Table II. Birth outcomes for U.S.-born non-Hispanic white, U.S.- and foreign-born Asian-Indian, and U.S.- and foreign-born Mexican mothers — U.S. births, 1995–2000

Birth outcome	U.S.-born white (*n* = 4,005,671)	Foreign-born Asian-Indian (*n* = 76,618)	U.S.-born Asian-Indian (*n* = 4285)	Foreign-born Mexican (*n* = 1,408,797)	U.S.-born Mexican (*n* = 928,801)
Birth characteristic					
Mean GA (weeks)	39.1	38.9	38.9*	39.1*	38.9*‡
% Prematurity (< 37 weeks)	14.85	16.73*	16.64*	16.04*	18.21*‡
Mean birth weight (g)	3439	3174*	3203*†	3388*	3332*‡
% LBW (≤2500 g)	3.71	6.91*	6.70*	3.66	4.65*‡
% VLBW (≤1500 g)	0.67	0.79	0.93	0.69*	0.90*‡
% SGA	2.61	6.34*	5.58*	2.93*	3.37*‡
Mortality (per 1000)					
Neonatal (per 1000 live births)	1.28	1.28	1.40	1.29	1.52*‡
500–1499g	61.80	59.80	50.00	62.92	68.41
1500–2499g	5.95	2.27*	0	7.16	5.53
≥2500g	0.63	0.65	1.01	0.59	0.64
Postneonatal (per 28-d survivors)	1.67	1.11*	0.93	1.45*	2.05*‡

Data source: Centers for Disease Control, Birth Cohort File, 1995–2000.
Includes all U.S. births from states that reported births to Asian-Indian and Mexican women with a known birth weight > 500 g.
*Compared with U.S.-born non-Hispanic white mothers, χ^2 or *t* test, $P < .001$.
†Compared with foreign-born Indian-Asian mothers, χ^2 or *t* test, $P < .001$.
‡Compared with foreign-born Mexican mothers, χ^2 or *t* test, $P < .001$.

women. Alcohol and tobacco use, hypertension, preeclampsia and eclampsia, and placenta previa were important risk factors for LBW in all groups.

Compared with whites, the odds of LBW increased from an advantageous 0.94 (CI 0.93 -0.95) in foreign-born to a disadvantageous 1.20 (CI 1.18-1.19) in U.S.-born Mexican

Table III. Odds ratio and 95% confidence interval for low birth weight for U.S.-born non-Hispanic white, U.S.- and foreign-born Asian-Indian, and U.S.- and foreign-born Mexican mothers—U.S. births, 1995–2000

Characteristic	U.S.-born white (n = 13,420,735)	Foreign-born Asian-Indian (n = 105,387)	U.S.-born Asian-Indian (n = 5021)	Foreign-born Mexican (n = 1,917,615)	U.S.-born Mexican (n = 1,194,209)
Maternal age (years)					
≤19	1.16 (1.14, 1.18)	1.64 (1.28, 2.10)	1.20 (0.71, 2.05)	1.45 (1.42, 1.49)	1.19 (1.17, 1.22)
20–34	1.00	1.00	1.00	1.00	1.00
≥35	1.26 (1.25, 1.28)	1.15 (1.06, 1.25)	1.32 (0.91, 1.92)	1.35 (1.32, 1.39)	1.40 (1.35, 1.45)
Maternal education					
<High school	1.80 (1.77, 1.83)	1.10 (0.98, 1.24)	1.26 (0.83, 1.93)	1.04 (0.99, 1.09)	1.32 (1.27, 1.38)
High school	1.38 (1.37, 1.40)	1.14 (1.06, 1.23)	0.99 (0.70, 1.38)	1.05 (1.00, 1.11)	1.16 (1.12, 1.21)
Some college	1.17 (1.16, 1.19)	1.07 (1.00, 1.15)	1.12 (0.83, 1.51)	1.07 (1.01, 1.13)	1.08 (1.03, 1.13)
4-year college	1.00	1.00	1.00	1.00	1.00
Unknown	1.55 (1.49, 1.62)	0.99 (0.82, 1.20)	1.79 (0.80, 4.00)	1.11 (1.03, 1.19)	1.49 (1.36, 1.64)
Initiation of prenatal care					
1st trimester	1.00	1.00	1.00	1.00	1.00
2nd trimester	1.10 (1.08, 1.11)	0.97 (0.88, 1.06)	1.12 (0.77, 1.63)	0.96 (0.94, 0.98)	1.05 (1.02, 1.07)
3rd/none/unknown	1.76 (1.73, 1.80)	1.35 (1.21, 1.50)	1.45 (0.92, 2.28)	1.24 (1.21, 1.27)	1.51 (1.46, 1.56)
Substance use					
Alcohol use	1.32 (1.27, 1.38)	1.36 (0.61, 3.01)	—	—	1.30 (1.16, 1.45)
Tobacco use	1.83 (1.81, 1.86)	0.90 (0.47, 1.73)	2.52 (1.30, 4.92)	2.08 (1.87, 2.32)	1.65 (1.57, 1.74)
Pregnancy complications					
Hypertension	3.42 (3.37, 3.48)	5.68 (5.06, 6.38)	6.11 (3.89, 9.58)	4.84 (4.69, 5.00)	3.96 (3.83, 4.09)
Pre-eclampsia/eclampsia	5.48 (5.18, 5.80)	7.03 (4.36, 11.33)	—	4.95 (4.43, 5.53)	4.89 (4.41, 5.41)
Diabetes	1.03 (1.00, 1.06)	1.07 (0.96, 1.19)	0.83 (0.45, 1.54)	0.99 (0.95, 1.04)	0.94 (0.89, 1.00)
Placenta previa/abruption	9.56 (9.32, 9.79)	5.18 (4.31, 6.22)	8.19 (4.11, 16.31)	9.34 (8.85, 9.86)	8.77 (8.26, 9.31)
Anemia	0.92 (0.89, 0.95)	0.96 (0.78, 1.18)	0.41 (0.12, 1.43)	0.84 (0.79, 0.90)	0.84 (0.79, 0.90)

Data source: Centers for Disease Control, Birth Cohort File, 1995–2000.
Includes all U.S. births with a known birth weight > 500 g.
Logistic regression stratified by maternal race/ethnicity/nationality with 95% confidence interval shown in parentheses.
All predictor variables entered simultaneously for each maternal race/ethnicity/nationality group.

women. The odds of LBW compared with white women were significantly higher and similar in both foreign-born, 2.37 (CI 2.3-2.4) and U.S.-born, 2.18 (CI 1.95-2.18) Indian women (details of these results available on request). However, because the confidence limits of the 2 Asian Indian groups do not overlap, there is a slight reduction in the risk of LBW in U.S.-born women.

DISCUSSION

We have previously shown with a California dataset that foreign-born Asian Indian women, despite a low-risk sociodemographic profile, have an increased incidence of LBW infants.[15] However, the small numbers of births in this dataset did not allow for the examination of outcomes in U.S.-born Asian Indian women. In this study we used a larger national dataset to determine risk factors and outcomes in *both* foreign- and U.S.-born Asian-Indian women. Sociodemographic factors traditionally associated with LBW failed to explain the higher incidence of LBW in this population. Foreign- and U.S.-born Mexican-American births were contrasted to the Asian-Indian immigrant experience. The epidemiologic paradox in foreign-born Mexican women who, despite having less education and later initiation of prenatal care, have good perinatal outcomes (comparable to white women) and the decrease in this advantage in the subsequent generation of U.S.-born Mexican-American women has been well described.[13,14] Our study confirms these findings, thus validating the dataset used for the study. It has been speculated that increased exposure to tobacco and alcohol as similarly seen in this study, a household composition with less familial and social support, and an increased incidence of unwanted pregnancies may all contribute to the worse perinatal outcome in this group.[24,25]

Foreign-born Asian-Indian women, on the other hand, have a low-risk sociodemographic profile but a paradoxically higher incidence of prematurity, LBW, and SGA infants. On the basis of their high percentage of LBW, one would also predict an increased NMR. However, as shown previously the more favorable birth weight–specific mortality rate (Table II) of Asian-Indian infants compensated for their increased percentage of LBW, resulting in an NMR that was similar to that of the white and Mexican infants.[15] There was a slight increase in teen pregnancies and tobacco use in U.S-born Asian-Indian infants compared with their foreign-born counterparts. However, a higher percentage accessed first trimester prenatal care and graduated from college as well. The incidence of maternal diabetes was also lower in U.S-born

Asian-Indian women compared with foreign-born women. Although sociodemographic factors differed across generations of Asian-Indian women, with the exception of a 29-g increase in mean birth weight and a minimal decrease in the odds of LBW, birth outcomes were unchanged.

Perhaps the most intriguing finding was the high incidence of LBW infants in Asian-Indian mothers, which remained unaffected by place of birth (foreign- or U.S.-born), maternal age, or education. This raises the question—*Why do Asian-Indian women have a higher incidence of LBW infants?* An increased incidence of LBW infants can result from either an increase in the incidence of preterm births or an increase in the proportion of SGA infants or the use of inappropriate cutoff points and standards for LBW and SGA, as was suggested by Rooth[26] more than 30 years ago. Although the incidence of prematurity was slightly higher in the Asian-Indian mothers compared with U.S.-born white women (16.7% vs 14.9%), this does not account for the 1.5-fold increase in the incidence of LBW infants or the 2-fold increase in SGA infants.

Birth weight is determined by an interaction of maternal, fetal, and placental factors. Prior studies have shown hypertensive diseases and preeclampsia,[27] antepartum hemorrhage,[28] maternal smoking,[29] maternal education and socioeconomics,[30] and characteristics such as body mass index, prenatal attitude to pregnancy, stress, acculturation, and social support[31-33] are risk factors for delivering a LBW infant. Although we were unable to assess maternal stress or social support, none of the other risk factors were associated with the increase in LBW infants observed in this population of Asian-Indian women.

Others have shown that maternal birth weight and especially the birth weights of relatives in the maternal line are more strongly associated with the birth weight of the infant.[34] We were unable to obtain information about maternal birth weight or maternal diet and nutrition in this study. The incidence of maternal anemia, a marker for nutritional status was not increased in Asian-Indian women (Table I).

The incidence of diabetes, particularly in foreign born women, was higher in Asian Indian women compared with white women. Diabetes depending on the type and severity increases the risk of adverse birth outcomes such as macrosomatia, low birth weight, prematurity, fetal death, and congenital anomalies.[22,35] In general, more severe stages of diabetes are associated with vascular compromise and smaller than expected birth weights. In a study of pregnancy outcomes among South Asian women in Norway, the prevalence of pregestational diabetes was almost twice as high as in Norwegians.[23] Maternal diabetes was associated with increased risk for LBW, and other perinatal complications. Information regarding type and severity of diabetes was not available in the birth registry data used in our study thus making it impossible to assess the impact of the incidence of maternal diabetes on the birth weights of Asian Indian infants.

Fetal conditions such as infections and congenital anomalies increase the risk of decreasing fetal growth.[36] The incidence of congenital anomalies was not increased in Asian-Indian infants (data not shown).

Placental factors affect fetal growth, and there is a strong relationship between placental dysfunction and decreased fetal growth. In a previous study an increased incidence of fetal deaths was observed among Asian-Indian women, possibly indicating that placental factors may be involved.[15] Information regarding detailed examination of the placenta or assessment of the placental circulation was not available in this study. It is possible that unidentified genetic or environmental factors may play a role in the increased incidence of SGA infants.

Several studies have debated the use of LBW on the basis of current growth curves that have been based on predominantly white American populations as a marker for increased morbidity risk in multiethnic populations.[37-40] Use of these growth curves may result in an inaccurate categorization of small for gestational age and its postnatal complications. In this study we assessed birth weight against the standard for the white population and used a birth weight <2500 g to define LBW. Using this traditional approach we identified a large number of small infants. However, we were unable to demonstrate a mortality disadvantage in these small infants (Table II). From the perspective of death, the improved birth weight–specific mortality at 1500 to 2500 g suggests that these infants are less biologically mature than white infants of equivalent birth weight. What is not known is whether these "small" Indian infants have the increased morbidity typically associated with intrauterine growth restriction. We are now conducting a more detailed analysis of the morbidity characteristics associated with LBW and SGA in Asian-Indian infants.

One of the limitations of our study is that many important factors that could influence fetal growth are not included on the birth certificate. These include stress and psychosocial factors, prenatal attitude to pregnancy, and access to medical care during pregnancy. Another limitation was that information regarding tobacco and alcohol use was not uniformly reported across States. However, the data on the increase in tobacco and alcohol use across generations are likely reflective of trends.

The continued persistence of the more than 2-fold increase in the risk of LBW in the next generation of Asian-Indian women indicates that there is much more to be learned about fetal growth. Specifically, what are the biologic and genetic risk factors affecting fetal growth, and are there different factors operating in different ethnic groups? How do social factors, acculturation, and maternal stress affect fetal well-being? Is there an intergenerational effect that would result in a gradual increase in the birth weight of infants with each generation? Further research is necessary to answer these questions and enhance our knowledge in the area of intrauterine growth and fetal well-being.

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