Differences in Neonatal Mortality Among Whites and Asian American Subgroups

Evidence From California

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Objective: To obtain information about health outcomes in neonates in 9 subgroups of the Asian population in the United States.

Design: Cross-sectional comparison of outcomes for births to mothers of Cambodian, Chinese, Filipino, Indian, Japanese, Korean, Laotian, Thai, and Vietnamese origin and for births to non-Hispanic white mothers. Regression models were used to compare neonatal mortality across groups before and after controlling for various risk factors.

Setting: All California births between January 1,1991, and December 31, 2001.

Participants: More than 2.3 million newborn infants.

Main Exposure: Racial and ethnic groups.

Main Outcome Measure: Neonatal mortality (death within 28 days of birth).

Results: The unadjusted mortality rate for births to non-Hispanic white mothers was 2.0 per 1000. The unadjusted mortality rate for births to Chinese and Japanese mothers was significantly lower (Chinese: 1.2 per 1000, *P*<.001; Japanese: 1.2 per 1000, *P*=.004), and for births to Korean mothers the rate was significantly higher (2.7 per 1000, *P*=.003). For infants of Chinese mothers, observed risk factors explain the differences observed in unadjusted data. For infants of Cambodian, Japanese, Korean, and Thai mothers, differences persist or widen after risk factors are considered. After risk adjustment, infants of Cambodian, Japanese, and Korean mothers have significantly lower neonatal mortality rates compared with infants born to non-Hispanic white mothers (adjusted odds ratios, 0.58 for infants of Cambodian mothers, 0.67 for infants of Japanese mothers, and 0.69 for infants of Korean mothers; all *P*<.05); infants of Thai mothers have higher neonatal mortality rates (adjusted odds ratio, 1.89; *P*<.05).

Conclusions: There are significant variations in neonatal mortality between subgroups of the Asian American population that are not entirely explained by differences in observable risk factors. Efforts to improve clinical care that treat Asian Americans as a homogeneous group may miss important opportunities for improving infant health in specific subgroups.

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SIAN AMERICANS COMprise a large and growing portion of the US population, but a firm understanding of patterns of care and outcomes in Asian American neonates remains elusive.[1] One important challenge is the potential for variations across the diverse national origin subgroups that make up the larger Asian American population. In demography and related fields, it is increasingly common to find work that differentiates a dozen or more subgroups that vary substantially in socioeconomic characteristics, cultural norms, and other attributes that could influence health care use and outcomes.[2-4] In health care, relying on information about the Asian American population as a whole when making policy or clinical judgments or broadly applying information about just 1 or 2 subgroups may miss important distinctions and lead to poorly targeted actions.

A number of existing studies provide useful information about birth outcomes for Asian Americans[5-25]; however, the existing literature provides only limited insight into subgroup variations within this population. Many studies analyzed data from the 1980s, and virtually all of them, particularly those incorporating risk adjustment and stronger analytic methods, have been forced by data constraints or other factors to focus on either the Asian American population as a whole or only the larger subgroups, usually Chinese, Japanese, Filipino, or Korean. Differences in study methods can also make it difficult to compare results across studies.

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The primary objective of this article is to provide a systematic comparison of neonatal mortality across many subgroups of the Asian American population. We studied data on births in California between January 1, 1993, and December 31, 2001, and examined 9 national origin subgroups including Cambodian, Chinese, Filipino, Indian, Japanese, Korean, Laotian, Thai, and Vietnamese neonates, along with non-Hispanic white neonates for comparison.

A second objective of this article is to evaluate the contribution of observable risk factors to variations in neonatal mortality across Asian American subgroups. Developing better information about risk factors could be helpful in targeting new health improvement efforts for Asian Americans, but the role of risk factors remains poorly understood, particularly across the many population subgroups.

METHODS

DATA

We used data from the California Office of Statewide Health Planning and Development, which links vital statistics records (birth and death certificates) with mother and infant hospital discharge data for more than 99% of in-hospital births in California. We limited our analysis to singleton livebirths between January 1, 1991, and December 31, 2001, with a birth weight between 500 and 5500 g and a gestational age of 44 weeks or less, for which a complete linkage of maternal hospitalization, infant hospitalization, and vital statistics data was achieved.

Using the convention of the Centers for Disease Control and Prevention, we classified each birth based on the race and ethnicity of the mother as reported on the birth certificate. Race and ethnicity data from the birth certificate have been found to be of high quality for these groups.[6] We included Asian American neonates with any of the 9 maternal national origins separately identified on the California birth certificate: Cambodian, Chinese, Filipino, Indian, Japanese, Korean, Laotian, Thai, and Vietnamese. This excluded Asian American births with unspecified maternal national origin or with other national origins that were not coded separately. We selected all infants born to non-Hispanic white mothers as our reference group. We excluded a few neonates born with lethal anomalies (anencephaly, cervical spina bifida, autosomal dominant polycystic kidney disease, trisomy 13, and trisomy 18), as well as infants with missing data for any of the risk-adjustment variables we used in the analysis. The final analytic sample contained complete information on a little more than 2.3 million births. The study was approved by the institutional review board at Stanford University, the California Department of Health and Human Services Committee for the Protection of Human Subjects, and the California Office of Statewide Health Planning and Development.

VARIABLES

Our main outcome measure was neonatal mortality, defined as death within 28 days of birth and coded using death certificate mortality information. Our main independent variable was race and ethnicity. The risk-adjustment models also incorporated additional controls. From birth certificates, we developed measures of maternal age (≤20, 21-29, or ≥30 years), years of maternal education (≤8, 9-11, or ≥12 years), maternal origin (US or foreign born), parity (0, 1-3, or ≥4 previous births), when prenatal care began (in the third trimester or before the third trimester), sex-specific neonatal birth weight indicators (500-749,

750-999, 1000-1249, 1250-1499, 1500-1999, 2000-2499, 2500-3999, or 4000-5500 g), and neonatal gestational age (<28, 28-32, 33-35, 36-37, 38-42, or 43-44 weeks). From data recorded on the birth certificates, we created indicators for the presence of any pregnancy risk factor and for the presence of any labor and delivery complication. From the hospital discharge data, we coded 49 groups of major anomalies using the diagnosis and procedure codes from the birth and immediate subsequent hospitalizations. These variables included anomalies of the gastrointestinal, genitourinary, central nervous, cardiopulmonary, and musculoskeletal systems; anomalies of the skin; chromosomal abnormalities; and other miscellaneous conditions. We grouped these anomalies into 4 categories (high risk, moderately high risk, moderately low risk, and low risk) based on the relative risk of mortality associated with each. We also created an indicator variable for the presence of any of 11 other medical complications recorded on the delivery discharge record. Some of these are similar to complications recorded on the birth certificates, but including them in models contributes additional explanatory power.[26]

ANALYTIC METHODS

After computing descriptive statistics and conducting bivariate comparisons, we used individual-level multivariate logistic regression models to examine differences in neonatal mortality for births to mothers of Asian origin and non-Hispanic white mothers, adjusting for various risk factors. We analyzed 3 model specifications. First, we estimated a model that included only dummy variables for race and ethnicity groups and a linear time trend. This model produced estimates of differences across the subgroups without adjusting for any characteristics of mothers or babies. Second, we estimated a model in which we included the full set of risk adjusters described: sex-specific birth weight categories, gestational age, maternal age, years of maternal education, maternal place of birth, start of prenatal care, presence of pregnancy risk factors, presence of complications of labor and delivery, and presence of major anomalies and other complications recorded on hospital discharge records. Third, since birth weight and gestational age seem to have central roles in neonatal survival, we estimated an intermediate risk adjustment model in which we adjusted only for sex, birth weight, and gestational age and did not include the other risk adjusters. Comparing results of the intermediate model with the full-risk adjustment model provided information about the contribution of different risk adjusters to the results.

The coefficients on the race and ethnicity variables from each of these models provided information about differences across groups. In each model, non-Hispanic white was the excluded (reference) group; thus, each odds ratio reflects the difference between neonatal mortality in the given group and that for infants born to non-Hispanic white mothers. We computed robust standard errors for each coefficient and calculated receiver operating characteristic curves to assess the goodness of fit of the logistic models.[27] All analyses were performed using STATA statistical software (version 8.0; StataCorp, College Station, Tex). An appendix with further details on data definitions, analytic approaches, and alternate analyses is available on request from the authors.

RESULTS

Of the 2 304 301 neonates in our data set, 483 246 (21%) were born to Asian American mothers and the remaining 1 821 055 (79%) to non-Hispanic white mothers. **Table 1** gives the number of births by subgroup. Three national origin subgroups, that is, Chinese, Filipino, and

Table 1. Maternal Characteristics by Group

Characteristic	Cambodian (n=17 677)	Chinese (n=116 795)	Filipino (n=138 389)	Indian (n=47 006)	Japanese (n=29 762)	Korean (n=39 641)	Laotian (n=12 978)	Thai (n=5722)	Vietnamese (n=75 276)	All Asian Americans (N=483 246)	Non-Hispanic White (n=1 821 055)
Age, y											
≤20	12.5*	0.7*	5.3*	1.0*	1.3*	1.0*	19.0*	11.1*	3.5*	3.6*	6.9
21-29	59.7	39.0	50.4	66.8	33.3	54.3	59.9	45.6	54.6	49.7	51.8
≥30	27.9	60.3	44.3	32.2	65.5	44.7	21.0	43.3	41.9	46.7	41.3
Education, y											
≤8	39.0*	6.0*	1.1*	2.0*	0.3*	0.5*	34.8*	6.9*	13.1*	6.5*	0.9
9-11	16.5	5.9	5.2	5.3	1.3	1.5	17.8	10.4	11.6	6.6	8.9
≥12	44.6	88.1	93.7	92.6	98.5	98.0	47.5	82.8	75.2	86.9	90.2
Maternal origin											
US born	2.0*	10.4*	15.1*	5.2*	48.4*	3.3*	2.8*	4.9*	1.1*	10.9*	89.7
Foreign born	98.0	89.7	84.9	94.8	51.6	96.8	97.2	95.1	99.0	89.1	10.3
When Prenatal care began											
1st or 2nd Trimester	97.2*	98.5*	97.2*	98.2	99.0*	97.5*	96.7*	97.3*	98.1	97.9*	98.2
3rd Trimester	2.9	1.5	2.8	1.8	1.1	2.5	3.3	2.7	1.9	2.1	1.8
Previous births											
0	32.6*	48.9*	43.8*	49.1*	49.1*	47.3*	32.6*	51.4*	45.0*	45.7*	42.1
1-3	41.9	47.6	49.0	47.0	46.8	49.5	39.4	43.8	45.1	47.2	49.0
≥4	25.6	3.4	7.3	3.9	4.0	3.2	28.0	4.8	9.9	7.1	8.9

*The distribution for the given Asian American subgroup is significantly different from that for the non-Hispanic white group; $P<.01$. Because of rounding percentages may not total 100.
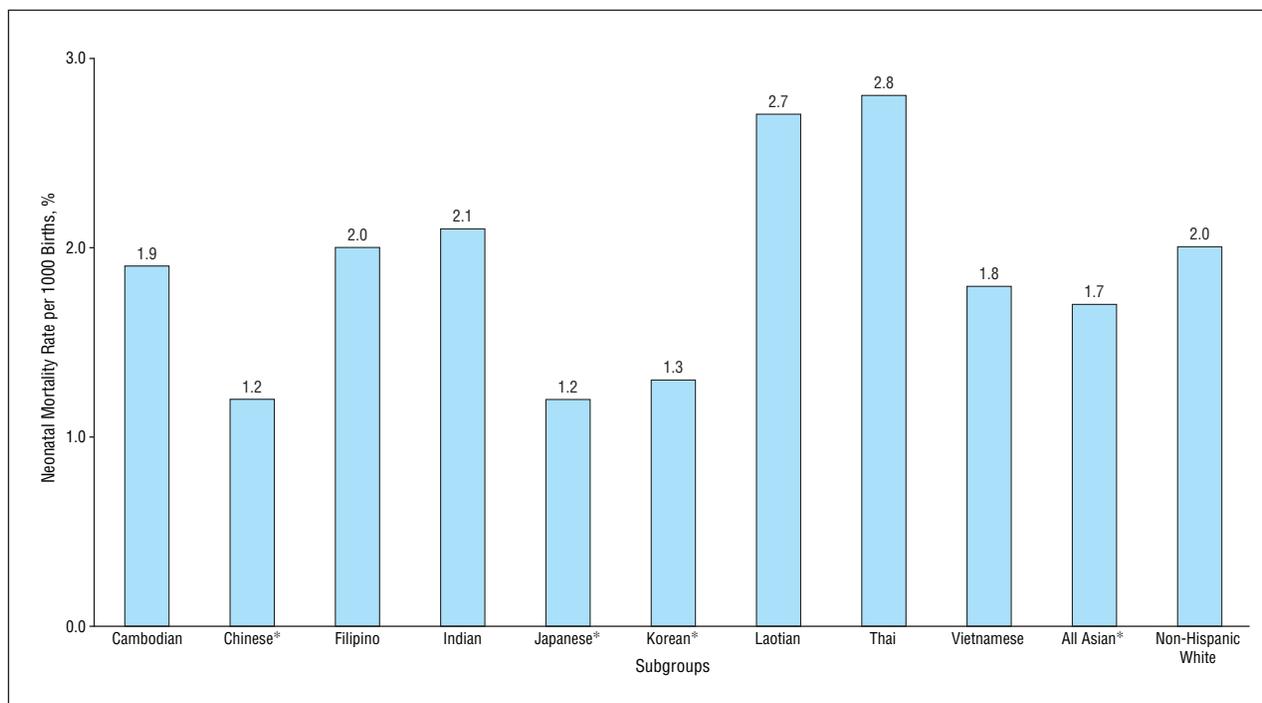
Figure 1. Unadjusted neonatal mortality rates for Asian American subgroups and non-Hispanic whites. *Groups for whom the unadjusted mortality rate is significantly different from the rate for non-Hispanic whites at the .01 level.

Vietnamese, comprise more than two thirds of the Asian American portion of the sample.

UNADJUSTED NEONATAL MORTALITY

The unadjusted 28-day mortality rate across all infants is a little more than 1.9 per 1000 births. There are large differences in unadjusted neonatal mortality rates across the subgroups in our sample (**Figure 1**). Infants born to women of Chinese, Japanese, and Korean national origin have significantly lower unadjusted neonatal mortality rates than infants born to non-Hispanic white women (all $P<.01$). Infants born to women of Thai and Laotian national origin have the highest mortality rates.

Table 2. Sex, Birth Weight, and Gestational Age by Group

Characteristic	Cambodian	Chinese	Filipino	Indian	Japanese	Korean	Laotian	Thai	Vietnamese	All Asian Americans	Non-Hispanic White
Sex											
Male	51.1	52.1*	52.0*	52.0†	51.4	51.8	51.5	51.5	51.6	51.8*	51.4
Female	48.9	48.0	48.0	48.0	48.7	48.2	48.5	48.5	48.4	48.2	48.6
Birth weight, g	3162*	3303*	3241*	3191*	3256*	3348*	3157*	3255*	3215*	3252*	3460
VLBW	0.8*	0.4*	0.9*	0.8*	0.5*	0.5*	0.8*	0.7*	0.5*	0.6*	0.6
LBW	7.2*	4.1*	6.7*	7.4*	5.1*	3.6*	7.3*	6.0*	5.0*	5.5*	3.9
Gestational age, wk											
<28	0.6*	0.2*	0.4*	0.4*	0.3*	0.3*	0.6*	0.4*	0.3*	0.3*	0.4
28-32	1.4	0.4	1.0	0.7	0.5	0.5	1.5	1.1	0.7	0.8	0.7
33-35	4.9	1.6	3.1	2.3	1.6	1.5	5.0	3.3	2.5	2.5	2.0
36-37	9.3	4.9	7.4	5.9	5.1	4.4	8.9	8.0	6.4	6.2	5.4
38-42	78.6	88.5	83.4	86.7	87.7	87.8	78.2	81.4	85.1	85.5	85.3
43-44	5.2	4.4	4.7	4.1	4.7	5.5	6.0	5.8	5.0	4.7	6.3

Abbreviations: LBW, low birth weight (<2500 g); VLBW, very low birth weight (<1500 g).
*$P<.01$.
†Value for the Asian American subgroup is significantly different from that for the non-Hispanic white group; $P<.05$. Because of rounding, percentages may not total 100.

Neonatal mortality rates in these 2 groups are not significantly different from rates for infants born to non-Hispanic white women, though they are significantly different from rates for infants born to Chinese, Japanese, and Korean women. The neonatal mortality rates for infants born to Cambodian, Filipino, Indian, and Vietnamese women are not statistically different from those for infants born to non-Hispanic white mothers.

DEMOGRAPHIC CHARACTERISTICS AND RISK FACTORS

Some of the differences in unadjusted neonatal mortality rates shown in Figure 1 may be related to differences in underlying population characteristics. Table 1 summarizes information about maternal characteristics for non-Hispanic white and Asian American subgroups and reports statistical significance from χ^2 tests of the hypothesis that values for each Asian American subgroup are the same as for the non-Hispanic white group.

There is considerable variation in maternal age across Asian American subgroups. Mothers of Chinese and Japanese national origin are more likely to be older than 30 years compared with non-Hispanic white mothers. Mothers of Cambodian, Laotian, and Thai national origin are more likely than non-Hispanic white mothers to be younger than 20 years. Mothers of Cambodian, Laotian, and Vietnamese national origin have the fewest years of education, and mothers of Filipino, Indian, Japanese, and Korean national origin the most. Cambodian and Laotian mothers also have the highest rate of starting prenatal care in the third trimester and the highest parity.

Table 2 lists key characteristics of neonates in our samples. Mean birth weight in each of the Asian American subgroups was lower than the mean for the non-Hispanic white group. Birth weights were highest for infants born to Chinese and Korean mothers, and lowest for infants born to Cambodian, Indian, and Laotian mothers. Very low birth weight was lower for infants born to

Chinese, Japanese, Korean, and Vietnamese mothers than for infants born to non-Hispanic white mothers.

Comparing all Asian American births with non-Hispanic white births, differences in gestational age are small. The rates of term births are similar, but infants born to Asian American women are less likely to have a gestational age greater than 42 weeks and, correspondingly, generally more likely to have a gestational age less than 38 weeks. There are noticeable differences across subgroups, with the lowest rates of premature birth for women of Chinese, Japanese, and Korean national origin and the highest rates for women of Cambodian, Laotian, and Thai origin.

Women in all of the Asian American subgroups had fewer pregnancy risk factors reported on birth certificates compared with non-Hispanic white women, and fewer reported complications coded on the discharge abstracts (**Table 3**). Women in 5 of 9 subgroups had fewer complications of labor and delivery reported on birth certificates compared with non-Hispanic white women. Infants born to women of Chinese, Japanese, Korean, and Filipino national origin also had lower reported prevalence of major anomalies.

ADJUSTED NEONATAL MORTALITY

To investigate the importance of risk factors, we estimated a series of regression models that progressively incorporated controls for risk factors (**Table 4**). These models include indicators for each subgroup and control for time trends. Model 1 includes no risk adjusters; model 2 adjusts only for sex-specific birth weight distribution and gestational age; and model 3 includes the full set of risk adjusters.

Without any risk adjustment, consistent with the results in Figure 1, infants born to women of Chinese, Japanese, and Korean national origin are at significantly lower risk for neonatal mortality compared with infants born to non-Hispanic white women (model 1). Given the rela-

Table 3. Infant Risk Factors by Group

Risk Factor	Cambodian	Chinese	Filipino	Indian	Japanese	Korean	Laotian	Thai	Vietnamese	All Asian Americans	Non-Hispanic White
Pregnancy risk factors*	4.3†	6.7†	9.5†	9.3†	8.0†	4.5†	6.4†	8.4†	5.5†	7.4†	13.0
Complications of labor or delivery‡	15.4†	17.0	18.4†	17.6	15.9†	14.0†	17.0	18.4§	19.3†	17.5†	17.2
Anomalies‖											
High risk	0.11	0.05†	0.08†	0.13	0.10	0.08	0.12	0.02§	0.09§	0.08†	0.11
Moderately high risk	0.27	0.17†	0.24	0.20	0.19	0.20	0.18	0.16	0.22	0.21†	0.24
Moderately low risk	0.35	0.34	0.45†	0.43	0.30§	0.29†	0.45	0.42	0.38	0.38	0.38
Low risk	0.29	0.43†	0.41†	0.41	0.27†	0.35	0.29	0.49	0.36	0.39§	0.37
Other complications¶	8.1†	8.5†	10.4†	10.3†	7.6†	8.5†	7.9†	9.8†	7.5†	9.0†	11.4

*Based on birth certificate data. Includes pregnancy-related hypertension, eclampsia, chronic hypertension, renal disease, anemia, cardiac disease, lung disease, diabetes, Rh factor sensitization, hemoglobinopathy, uterine bleeding, hydramnios or oligohydramnios, incompetent cervix, herpesvirus, tobacco consumption, previous infant larger than 4000 g, and previous premature infant.

†$P<.01$.

‡Based on birth certificate data. Includes seizures, cephalopelvic disproportion, breech delivery, precipitous labor, premature rupture of the placenta, abruption placenta, placenta previa, other excessive bleeding, febrile fetus, moderate to heavy meconium, cord prolapse, fetal distress, and complications from anesthesia.

§Value for the Asian American subgroup is significantly different from that for the non-Hispanic white group; $P<.05$.

‖Derived from 49 major anomalies identified based on diagnosis and procedure codes from the hospital discharge abstracts. Additional details are available in an Appendix that is available from the authors on request.

¶Based on hospital discharge data. Includes oligohydramnios, placenta hemorrhage, prolapsed cord, premature ruptured membrane, fetal distress, fetus small for gestational age, fetus large for gestational age, hydrops fetalis, no isoimmunization, maternal complications, hemolytic disorder, and other high-risk maternal conditions.

Table 4. Results of Regression Analyses*

Ethnic Group	Model 1: No Risk Adjustment	Model 2: Adjusted for Sex, Birth Weight, and Gestational Age	Model 3: Full Risk Adjustment
Cambodian	0.975 (0.695-1.367)	0.714 (0.497-1.026)	0.577 (0.361-0.924)
Chinese	0.642 (0.543-0.758)	0.748 (0.628-0.891)	0.932 (0.752-1.156)
Filipino	1.018 (0.900-1.151)	0.759 (0.663-0.870)	0.835 (0.696-1.003)
Indian	1.115 (0.913-1.363)	0.865 (0.698-1.073)	0.940 (0.720-1.226)
Japanese	0.620 (0.446-0.861)	0.619 (0.442-0.867)	0.668 (0.449-0.995)
Korean	0.663 (0.503-0.874)	0.663 (0.492-0.893)	0.694 (0.486-0.991)
Laotian	1.357 (0.972-1.894)	1.143 (0.788-1.659)	0.949 (0.603-1.495)
Thai	1.439 (0.880-2.353)	1.319 (0.778-2.235)	1.887 (1.095-3.251)
Vietnamese	0.943 (0.795-1.119)	0.949 (0.793-1.136)	1.006 (0.798-1.269)

*Data are given as odds ratio (95% confidence interval). Non-Hispanic white category is omitted. Models also contain additional covariates as described in the text. Full regression results are given in an Appendix that is available from the authors on request.

tively rare occurrence of neonatal death, it is reasonable to interpret the odds ratios as relative risks,[28] so we infer that infants born to mothers in these groups have neonatal mortality rates more than 30% lower than those born to non-Hispanic white mothers.

Adjusting for the full set of risk factors affects several of the odds ratios (model 3). Infants born to Japanese and Korean mothers continue to have better outcomes than those born to non-Hispanic white mothers after these adjustments, but outcomes for infants born to Chinese mothers are no longer statistically significantly better. Mortality rates for infants born to Cambodian mothers, who were no different from infants born to non-Hispanic white women before adjustment, are about 40% lower when risk factors are accounted for. Outcomes for infants born to Filipino mothers are close to being significantly better than those for infants born to non-Hispanic white mothers. Mortality rates for infants born to Thai mothers are about 90% higher than for infants born to non-Hispanic white mothers on a risk-adjusted basis. **Figure 2**

shows the changes in odds ratios that result from risk adjustment.

Table 4 also gives results from an intermediate risk-adjustment model (model 2), which adjusts only for sex-specific birth weight distribution and gestational age. In many cases, odds ratios from this model fall between the unadjusted odds ratio and the fully adjusted odds ratio, indicating that birth weight and gestational age contribute some of the changes in the odds ratios observed but that other risk adjusters have important roles as well.

Calculated around the non-Hispanic white neonatal mortality rate of 2.0 deaths per 1000 births, the odds ratios we observed for infants born to mothers of Cambodian, Japanese, and Korean national origin in our fully adjusted model would translate into reductions of 0.9, 0.7, and 0.6, respectively, in mortality rate per 1000 births. The odds ratio for infants born to mothers of Thai national origin would imply a mortality rate per 1000 births that is higher by 1.8.
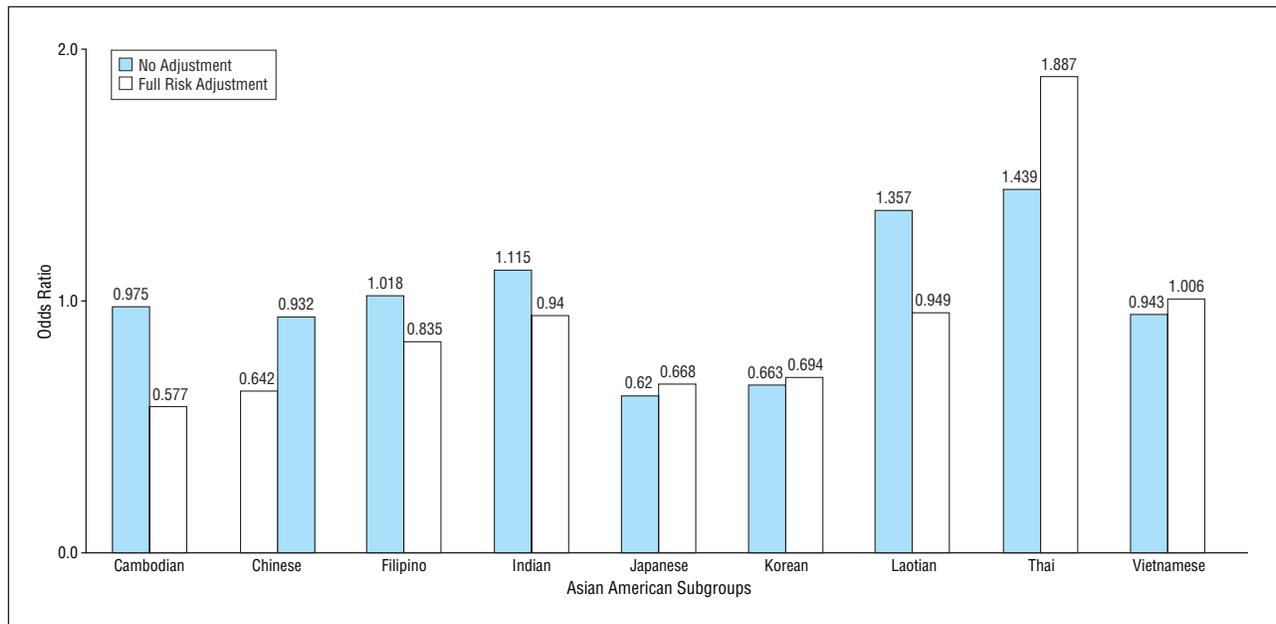
Figure 2. Odds ratios for neonatal mortality for Asian American subgroups relative to non-Hispanic whites, with no and full risk adjustment.

We have made all comparisons up to this point between the Asian American subgroups and the non-Hispanic white group. It may also be instructive to examine comparisons between the Asian American subgroups themselves. Using our fully adjusted model, we find that outcomes for infants born to Thai mothers are statistically significantly worse than outcomes for infants born to Cambodian ($P<.001$), Chinese ($P=.01$), Filipino ($P=.004$), Indian ($P=.02$), Japanese ($P=.002$), Korean ($P=.002$), Laotian ($P=.05$), and Vietnamese ($P=.03$) mothers. Other than for Thai neonates, there are no statistically significant differences when the various Asian American subgroups are compared with other subgroups.

COMMENT

In this large study of California births, we found noticeable variations in neonatal mortality across several Asian American subgroups. In particular, after adjusting for a variety of factors, we found significantly lower neonatal mortality in infants born to mothers of Cambodian, Japanese, and Korean national origin compared with infants born to non-Hispanic white mothers, and significantly higher rates for infants born to mothers of Thai national origin.

We also found that patterns of mortality rates are somewhat different in analyses that do and do not adjust for risk factors, suggesting that variations in risk factors have an important role in variations in mortality rates for some of the groups. There are 3 general patterns in the results. First, in 2 subgroups, controlling for maternal and infant characteristics and risk factors resulted in more favorable comparisons with the non-Hispanic white group. This was seen most strongly in births to Cambodian women, with outcomes similar to births to non-Hispanic white women before risk factors were considered,

but outcomes on a risk-adjusted basis were much better than for non-Hispanic white births. A similar pattern was observed for births to Filipino mothers, though they end up just short of statistically significantly different from non-Hispanic white births in the fully adjusted risk model. For births in these subgroups, levels of the maternal and infant characteristics and risk factors that we measured seem to be disadvantageous for non-Hispanic white births; thus, considering these factors improves the comparison with non-Hispanic white births.

Second, in 2 subgroups, controlling for maternal and infant characteristics and risk factors resulted in less favorable comparisons with non-Hispanic white births. For births to Chinese mothers, outcomes were statistically significantly better than for births to non-Hispanic white mothers before adjusting for risk factors, but when risk factors were considered there was no significant difference. This pattern was also observed for births to Thai women, in which outcomes were somewhat worse than outcomes for births to non-Hispanic white mothers on an unadjusted basis, though not statistically significantly so, but outcomes on a risk-adjusted basis were significantly worse. This pattern of change suggests newborn and maternal characteristics that are advantageous to non-Hispanic white births. When these advantages are controlled for, outcomes compare less favorably with non-Hispanic white births.

Third, in 5 subgroups, there was no change after adjusting for risk factors. For births to Japanese and Korean mothers, outcomes were better than for births to non-Hispanic white mothers before risk adjustment, and they remained better after risk adjustment, with relatively little change in the mortality odds ratios when risk adjustment was used. Among infants born to Indian, Vietnamese, and Laotian mothers, mortality rates were not significantly different from those for infants born to non-Hispanic white mothers before risk adjustment and they

remained insignificantly different after risk adjustment. This pattern implies risk factors that are functionally similar in these subgroups and the non-Hispanic white group.

That some groups are better off or worse off than the non-Hispanic white group after risk adjustment can also provide useful information about the net effect of risk factors. Outcomes for births to Cambodian, Japanese, and Korean women are better than for births to non-Hispanic white women on a risk-adjusted basis. One implication of this is that other factors contribute to better outcomes that both differ from those in the non-Hispanic white group and are not among the set of variables that we measured. Outcomes for births to Thai mothers were worse, with the implication that they were affected by other factors that were unobserved, different from those in the non-Hispanic white group, and contribute to worse outcomes.

We believe these results underscore the importance of expanding discussion of health care and outcomes for Asian American neonates to include greater consideration of the diverse set of national origin subgroups. Efforts to improve clinical care that treat Asian Americans as a homogeneous group may miss important opportunities for improving infant health in specific subgroups. In some of these subgroups (for example, births to Cambodian and Filipino mothers), a promising area for improvement might be to focus on reducing the incidence of risk factors. For births to Thai women, understanding the factors that drive worse outcomes on a risk-adjusted basis would be important. In other subgroups, the risk factors that we can observe seem to already be generally comparable to those in other groups, and further investigation may be required to identify areas for potential action. Benefits could, perhaps, be obtained by studying the causes of better outcomes for births to Japanese and Korean women.

This study used data on births in California. California has a large Asian American population and thus provides a valuable setting for study. Public use data from the US Census Bureau report that Asian Americans make up nearly 13% of California residents and that about one third of Asian Americans in the United States reside in California. While undoubtedly not completely representative of Asian Americans residing elsewhere, Asian Americans in California, as a group, are statistically similar in many respects to other Asian Americans, according to 2004 data from the US Census Bureau. Asian Americans in California have a poverty rate similar to that of Asian Americans elsewhere (12%), though the percentage in households with incomes greater than $100 000 is slightly higher in California than elsewhere (26% vs 22%). Forty-seven percent of Asian Americans residing in California having a bachelor's or graduate degree, compared with 49% of Asian Americans not residing in California. Thirty-four percent of Asian Americans residing in California were born in the United States, compared with 32% of Asian Americans not residing in California.

This study relied on administrative data that do not capture all aspects of care or health status. Further study with more detailed data sets that can capture other risk factors may contribute further valuable insights. Further explorations will also be needed to consider other potentially important interactions, such as the extent to which place of birth is related to the results we found for race and ethnicity. Most of the Asian American mothers in our sample were born outside of the United States, and patterns may change as the US-born Asian American population grows.

Data used herein include cases for which birth certificates could be matched to hospital discharge data records. This excludes out-of-hospital births and a few unlinkable in-hospital births. Some of the Asian American subgroups we studied may have higher rates of out-of-hospital births than others, and some evidence suggests that out-of-hospital births are associated with higher mortality rates than in-hospital births.[29] Our results would not capture these patterns. The results also apply to births for which complete data could be obtained on the risk adjustment variables of interest. This affects a small number of births, but patterns of missing data may vary by race and ethnicity, and births with missing data in these fields have disproportionately high mortality rates.

Substantial advances in understanding of birth patterns in this group nationwide will likely require additional, more detailed data. Many current data sources do not provide sufficient information about Asian American subgroups; only Chinese, Filipino, and Japanese national origin are separately identified on the standard US birth certificate. Further work with nationally representative data sets would clearly be valuable if the data to support such analysis were to become available.

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