Birth Weight across Ethnically Diverse Asian and Pacific Islander Populations: An Analysis of Mothers' and Fathers' Nativities and Ethnicities in a New Immigrant Destination

Background

Investigations of perinatal health have yielded rich insights into the ways that social contexts and social disparities get translated into health disadvantage, in an intergenerational manner, at the very beginning of life. The literature on preterm and low birth weight infants provides robust evidence to indicate that nativity and ethnicity are significant predictors of health status "at the starting gate," contributing to enduring, later life inequalities (Conley et al 2003). A key thread in this scholarship focuses on immigrant mothers' origins and their acculturation, such that greater degrees of acculturation (as indicated by generations of US residence or other estimations) tend to associate with greater health disadvantage for infants and children as compared to those borne to foreign born, relatively weakly acculturated women. Generalizing beyond the sizable population of immigrants and their 2nd-plus generation descendants originating in Latin America is one crucial step toward delineating the robustness of the Immigrant Epidemiological Paradox and its underpinning mechanisms. Additionally, conceptualizing acculturation in a manner that considers not only maternal characteristics, but also characteristics of the mother-father dyad, can provide a more contextualized, detailed image of the childbearing environment.

While the immigrant health literature has grown in depth and diversity over the past several decades, the bulk of this scholarship has focused upon births to Hispanic mothers. Relatively little attention has been paid to the perinatal health outcomes of Asian and Pacific Islander immigrant mothers. Whether due to lack of suitable data or ill-informed study design, health researchers have commonly used the blanket classification of Asian or Pacific Islander (API) and to analyze Asian mothers as a singular, monolithic group in epidemiological research (Qin & Gould, 2006) in analyses of health outcomes. The API category encompasses populations ranging from East Asian Chinese (the most numerous API origin group in the US) to Southeast Asian Filipinos, South Asian Indians and numerous Pacific Island nations and territories (e.g., John et al 2012).

Many methods of aggregation have masked the diversity among subgroups in this very broad category. For instance, socioeconomic differences are even greater among subgroups of this population than among Hispanic subgroups, yet Hispanic subgroups are often disaggregated in health literature. One of the early studies in a handful of analyses which disaggregate the "API" category, Frisbie, Cho and Hummer (2001) observe that although Asians are generally a healthy group, the self-evaluated health of Pacific Islanders and Vietnamese tends to be worse than that of Non-Hispanic Whites. Such differences within ethnic subgroups of the Asian and Pacific Islander population suggest a need for further, finely tuned analyses of perinatal health outcomes among such ethnic subgroups. Studies of the perinatal health outcomes of immigrants have often been limited to Hispanic/Latino populations, and findings often report an unusual paradox wherein such groups exhibit similar outcomes as white women, despite being characterized by relative socioeconomic disadvantage (e.g. Guarini et al, 2013; Osypuk, Bates & Acevedo-Garcia, 2010; Parrado & Morgan, 2008; Teruya & Bazargan-Hejazi, 2013). Yet the handful of past studies which meaningfully disaggregate API categories point to high levels of API heterogeneity as well. When they have been disaggregated (e.g., Qin and Gould 2006), Asian subgroups demonstrate widely variant perinatal health risks which demand ethnicity-specific investigations and interventions related to preterm, teen pregnancy, maternal education, parity and PNC access. Gestational diabetes rates vary widely among foreign-born Asian and Pacific Islander subgroups (Yuen & Wong, 2015). Acevedo Garcia et al (2005) find that foreign-born Asian mothers are significantly more likely to give birth to LBW infants than their native counterparts, while Fuentes-Afflick et al (1998) find no statistically significant difference in rates of LBW between foreign and native-born Asian women. Hyman and Dussault (2000), in semi-structured interviews with pregnant Southeast Asian women, find that higher levels of acculturation are associated with the presence of more negative health behaviors and less social support. Collectively, these studies give impetus to further analyses of national origin-specific perinatal outcomes in settings with large and diverse API populations.

Of particular interest to this paper are the factors influencing healthy birth outcomes across Pacific Islander populations, a group that has been notably neglected in U.S. scholarship. When Pacific Islanders have been involved in research they have often been combined with the Asian population or studied as a single ethnic group, i.e., "Pacific Islanders." Yet tremendous diversity exists within the Pacific Islander category. In those rare instances when the API category is disaggregated, Native Hawaiian and Pacific Island (NHPI) origin populations often face health care and health outcome disadvantages more severe than other subpopulations (Le et al 1996). Critical analyses published in the *Lancet* (Anderson et al 2006) and elsewhere suggest that API populations in the U.S. and globally experience remarkably heterogeneous health outcomes which warn against their aggregation (Le et al 1996). For instance, native Hawaiians experience high age-adjusted rates of mortality, low birth weight, cancer, diabetes and hypertension morbidity rates as compared to all other ethnicities in Hawai'i (Ibid). Micronesian populations, such as Marshall Islanders and Marianas Islanders, experience atypically high rates of cancer and other chronic conditions that associate with structural violence, such as low levels of medical expenditure, high rates of unemployment, and exposure to fallout from expansive U.S. nuclear testing (Hezel 2004). Failure to disaggregate PI individuals belies important intra-group differences inherent to the category such as highly variable rates of gestational diabetes (Cundy, Gamble, Manuel, Townend, & Roberts, 1993), birthweight (Sundborn, Schluter, Schmidt-Uili, & Paterson, 2011), and risk of preterm birth (Ju, Heyman, Garber, & Wojcicki, 2018). Further motivating our analyses of the Pacific Islander Family Study, conducted in New Zealand, which examine Pacific Islanders by detailed subgroup and find significant differences among these groups in terms of health behaviors and outcomes. Mother/infant co-sleeping practices and SIDS rates (Schluter, Paterson, & Percival, 2007), infant non-immunization (Paterson, Percival, Butler, & Williams, 2004), average birthweight (Sundborn et al., 2011), and pregnancy risk profiles (Martin, 1995) are just a few of the areas in which Pacific Islander subgroups diverge. By assuming a uniform risk profile among all Pacific Islander subgroups, policy makers and practitioners are in danger of crafting 'one size fits all' recommendations which ignore intra-group diversity in health beliefs and practices.

Disaggregating the Asian/Pacific Islander category into subgroups based on national origin shows striking differences in prevalence of LBW. Higher likelihood of LBW was found in Cambodian, Filipino, Indian, Japanese, Laotian, and Thai women, while lower likelihood was found in Chinese and Korean women (Fuentes-Afflick & Lurie, 1997). Differences in rates of short interpregnancy intervals (Delara, Madden, & Bryant, 2018), elevated pregnancy risk profiles, and levels of prenatal care (Martin, 1995) are also evident among these subgroups. Gould and colleagues' (2003) analyses of Asian Indian women in California revealed unexpectedly high rates of low birth weight in light of their high levels of education and affluence (Gould et al, 2003). Rao et al (2006) look at multiple measures of infant and maternal health across Asian and Pacific Islander subgroups and find statistically significant differences on several measures. While Indian/Pakistani mothers have the highest rates of pre-term delivery, Pacific Islander mothers have the highest rates of macrosomia. This study exemplifies a problem with research on Asian/Pacific Islander maternal and infant health: while Asian mothers were studied by subgroup (country of origin), Pacific Islander mothers were studied as a unified group. This lack of decomposition in PI subgroups masks the degree of difference between PI nationalities. In examining the distinct differences found across Hispanic subgroup studies, it is logical to assume that similar differences would be visible among PI subgroups. This study seeks to add to this body of knowledge by providing evidence of differences in PI maternal and infant health outcomes across national origin subgroups.

Despite the heightened risk of neonatal mortality and morbidities associated with macrosomia (i.e., heavy birth weight in excess of 4000g, or 4500g) (Zhang et al 2008), the condition has only rarely been analyzed in studies of ethnicity, immigration status and health in the U.S. When examining prevalence of macrosomia, differences related to nativity status and Asian/Pacific Islander subgroup again become apparent. Pacific Islander infants tend to be heavier on average than European infants and are at greater risk for macrosomia than other Asian subgroups (Rao et al, 2006). Pacific-born mothers living in New Zealand give birth to heavier babies than New Zealand-born Pacific mothers (Sundborn et al., 2011). Moore et al (2009) studied Caribbean and South Asian immigrant mothers living in Canada. Their finding that higher SES immigrant women were at significantly higher risk of LBW outcomes than foreign-born mothers with lower SES points to the possible negative influence of acculturation on birth outcomes. The interaction of maternal nativity and Asian/Pacific Islander ethnicity raises complex questions about the potential effects of acculturation, as well as underlying health conditions such as Type II diabetes and gestational diabetes, as they relate to conditions of LBW and macrosomia.

Paternal Characteristics and Perspectives on Acculturation

Literature on immigrant health has focused significant attention on the negative effects of acculturation on maternal and infant health. In the United States, foreign-born mothers exhibit different patterns of LBW and macrosomia than do native-born mothers of the same race/ethnicity. This relationship holds true both across and within ethnic and racial categories (Abraido-Lanza, Chao, & Florez, 2005). In line with the well-documented Epidemiological Paradox, foreign-born Hispanic mothers show lower rates of LBW than native-born Hispanic mothers, even when they exhibit less favorable maternal characteristics (Fuentes-Afflick, Hessol, & Pérez-Stable, 1998). Foreign-born Hispanic mothers have rates of LBW 19% lower than their native-born counterparts (Acevedo-Garcia, Soobader, & Berkman, 2005). When the Hispanic population is broken down into subgroups, distinct differences emerge by country of origin. While LBW rates are similar for mothers of Mexican, Cuban, and Central/South American infants, Puerto Rican infants have consistently higher LBW rates (Fuentes-Afflick & Lurie, 1997).

A plethora of studies have moved beyond maternal characteristics and demonstrated a unique influence of fathers' characteristics, in particular paternal *race*, upon perinatal health outcomes (Parker 2000). Much of this research has focused on White and Black parents, and tends to observe that while mothers' race is more influential for birth weight, fathers' race in interracial births is significant too, with Black-White interracial infant outcomes oftentimes more advantaged than those to two Black parents. Parker's (2000) finding that White fathers improve healthy birth weight odds among infants born to Black mothers, while Black fathers lessen healthy birth weight odds among infants born to White mothers, speaks to the privileging of whiteness and its extension, through birth outcomes, across generations. As Migone et al (1991) point out, patterns of LBW disparities linked to parental race reflect largely social, nongenetic factors, while genetic mechanisms are in play, but less prominent in explanatory frameworks.

While many studies examine *interracial* parent couples and paternal status impacts upon birth outcomes, demonstrating distinct birth outcomes across single-race and multi-racial parental pairs, few have considered mother-father nativity differences as they influence birth outcomes, and whether having one native born and one foreign born influences the associations between nativity status of parents and birth outcomes. A few instructive examples, such as Park et al's (2015) analyses of preterm birth, finds superior outcomes for immigrant parents with the same origin country, but not for immigrant parents from different countries or those with a Canadian-born partner. In one model study conducted in New Zealand, Sundborn and colleagues' (2011) in depth investigation of infant birth weight observes that while infants of Pacific Born mothers were heavier than infants of New Zealand-born Pacific Islander mothers, there was no additional difference attributable to father's ethnicity, or to ethnically heterogeneous versus ethnically homogeneous parents.

We seek to build on findings such as those of Sundborn's and the wider New Zealand-based Pacific Islander Family Study, and to address a paucity of analyses which disaggregate Asian and Pacific Island national origins and which jointly analyze maternal and paternal origins. These additions are necessary given that Asian origin immigrants are now the fastest growing …, surpassing Latin American immigration to the U.S. The rising significance of both interracial and immigrant-citizen parenting and the salience of diverse marriage/parenting racial and nativity patterns in conceptualizations of acculturation also motivate this study.

Study Hypotheses

1) Given the diversity of their origins, as well as the differential degrees to which health-related processes of selection influence overseas populations, we hypothesize that Asian and Pacific Islander women will exhibit diverse risks of bearing LBW and macrosomic infants across regional and national origins.

2) Building upon past findings on acculturation and health in US immigrant populations, we hypothesize that foreign born populations of mothers will fare more positively than their ethnic counterparts born in the U.S. Relatedly, we expect the difference in birth weight outcomes across foreign born and native born groups to be particularly marked for subgroups whose social position, in general, is likely eventuate in an acculturation process involving negative health behaviors, e.g., smoking and unhealthy diet.

3) Finally, we hypothesize that fathers' nativity status, distinct from that of mothers', will influence birth outcomes in a significant way. Specifically, we reason that when biological fathers are U.S. born, immigrant mothers will tend to be more acculturated, and hence the protective effect of their immigrant status will be attenuated. On the other hand, ethnic mothers who are US born, but who parent children with foreign born fathers, will experience less complete acculturation than those

having children with US born fathers, and hence their outcomes will be relatively advantaged in terms of LBW and macrosomia.

4) As macrosomia is an outcome that past research has found to be particularly pronounced in Pacific Islander populations, we seek to delineate more clearly which maternal national origin subgroups are more prone, and how fathers' characteristics, especially ethnicity, influence macrosomia risks. We hypothesize that, due to the high risks of macrosomia both in the immigrant first generation and within Polynesian settings, that U.S. born Pacific Islanders will experience shifts toward lower birth weights, an overarching trend that will tend to lessen risks of macrosomia in the 2+ generation.

Study Context

Pacific Islanders in the United States are largely concentrated in Western states. Utah has the fifth largest population of Pacific Islanders in the nation (Hixson, Hepler, & Kim, 2012) in part due to the Native Hawaiians' and Tongans' long association with the Mormon Church (Aikau, 2010; Fletcher-Stack, 2017). Although a relatively small percentage of the U.S. population, Pacific Islanders increased at a rate more than three times that of the total population in the first decade of the 21st century (Hixson et al., 2012). As NHPIs' numbers increase across the U.S., so do concerns with their health and well-being. NHPIs show concerningly high rates of diabetes, deaths due to cancer, obesity, cardiovascular disease among children and adults, and HIV infection ("Fact Sheet: What you should know about Native Hawaiians & Pacific Islanders (NHPI's)," 2010; Stafford, 2010). It is essential that social scientists and health professionals understand the specific risk profiles of racial/ethnic groups in order to best target interventions and health policies.

Utah's population diversity and demographic data resources make it an ideal context for analyzing health disparities among immigrants, in particular amongst API immigrants and native born populations. First, Salt Lake City and neighboring West Valley City have among the largest populations of Tongan and Samoan populations in the U.S. These populations, as well as those of other NHPIs have grown rapidly in recent decades (Utah Department of Health, 2017), resulting in NHPI subpopulations that are sufficiently numerous to conduct in-depth social and spatial analyses of health outcomes. State demographic data also demonstrate that members of NHPI groups exhibit a range of characteristics related to acculturation and socioeconomic marginalization. For instance, nearly one-quarter of NHPIs in Salt Lake City are foreign-born (Ibid). About 68% of Tongans and 45% of Samoans report speaking a language other than English at home (Ibid). Only about 7% of Tongans and 9% of Samoans hold a bachelor's degree, the lowest rates of any race group (Ibid). Whether these sociodemographic characteristics correlate with disadvantageous health outcomes among NHPIs is a question that, addressed empirically, will reveal valuable comparative data for health disparities scholarship.

Furthermore, the University of Utah hosts the one-of-a-kind demographic and genealogical data resource, the Utah Population Database, and has seen the creation of an interdisciplinary Pacific Islander Initiative that seeks to achieve prominence as one of the country's few centers for Pacific Islander Studies.

Methods

The analyses that follow draw upon data from the Utah Population Database (UPDB), a unique resource for biomedical research housed at the University of Utah's Huntsman Cancer Institute. Containing information on over xx million individuals, the UPDB is a comprehensive, continually updated system of linked vital, medical and administrative records. Information on the Resource for Genetic and Epidemiologic Research, the Utah state agency governing access to UPDB data, and protocols established to protect access and ensure UPDB data confidentiality, has been published elsewhere (Wylie and Mineau 2003). The privacy of individuals represented in UPDB records and confidentiality of the data is strictly protected. Prior to accessing the protected data source, the study authors each obtained approval from the Institutional Review Board at the University of Utah.

Because the UPDB's administrative birth certificate records are collected on all births, the data are not influenced by selection bias and other forms of sampling error that plague population-based samples or clinical samples. However, use of administrative records limits analytical possibilities, such as the ability to measure certain salient dimensions of the migration experience, such as duration of U.S. residence (Guendelman and English 1995). Additionally, as we note in our limitations, birth certificate records provide incomplete information on fathers' characteristics, especially in cases of nonmarital births.

The current study draws upon birth certificate records issued for all live, singleton births in Utah between 1978 and 2016 (N=1,679,202). The key outcome in this study is infant birthweight, in particular whether weight at birth is categorized as healthy/normal (i.e., between 2500 and 4000 grams) or whether infants are of low birth weight (i.e., less than 2,500 grams) or of heavy birth weight, i.e., macrosomic (i.e., greater than 4,000 grams).

Birth certificate records provide reports on mothers' and fathers' nativity (i.e., country of birth) and their race/ethnicity, allowing us to disaggregate immigrant and native born mothers into detailed regions and countries of origin, and for US born mothers, to characterize their ethnicity as Asian or Pacific Islander with a moderate degree of detail. While the UPDB allow us to categorize many birth mothers with a great detail of specificity, certain birth records continue to rely upon aggregate categories such "Other Pacific Islanders." We code PI mothers and fathers in the following subcategories: Samoan, Tongan, and Other Pacific Islanders. Mothers reporting Pacific Islander ethnicities other than the three categories above were counted as 'Other Pacific Islander,' however the category may contain women who technically have Tongan or Samoan ancestry, but whose birth certificates were completed with less specificity, such as use of the term "Pacific Islander" or "Polynesian."

While fathers' nativity and ethnicity can be coded with a parallel level of detail as mothers', albeit with a greater proportion of missing data, in this analysis we opt simply to code paternal nativity as US Born, Foreign Born, or Unknown, recognizing that a great detail of interracial partnering of substantive interest (worthy of future analysis) underlies this classification.

We also construct our covariates from birth certificate information. We include mother's age at the time of birth; mother's educational attainment; number of previous pregnancies, still births, and live births; birth interval between current birth and last birth; mother's weight gain during pregnancy; mother's pre-pregnancy BMI; mother's marital status; and year of child birth. We also include father's nativity (noted above) and educational attainment.

We created four categories of **mother's age**: (11-19), (20-35), (36-39), (40-49) from self-reports in birth certificates. Similarly, **mother's education** is categorized into four categories, which are 1. Less than high school education, 2. High school or GED, 3. More than high school education (Associate, Bachelors, Masters, PhD), and 4. Mother's education unknown. We created a variable, '**Birth Parity/Previous Pregnancies'** based on the reports on mother's previous live births, still births, or pregnancies. This variable includes five categories: 1. Those with no previous pregnancies, live births or still births, 2. Those with 1-2 previous births, live or still births, 3. Those with 3 previous pregnancies, live births, or still births, 4. Those with 4 previous pregnancies, live births, or still births, 5. Those with more than 4 previous pregnancies, live births or still births. We include information on **birth interval** between the current birth and the last birth. This is a 5-category variable. The categories include: 1. No interval (having first child), 2. Less than one year, 3. 1-2 years, 3. 2-3 years, 4. 3-5 years, and 5. Greater than 5 years. We created four categories on **mother's weight gain** information during the pregnancy. The categories are: 1. No weight gain during pregnancy (0), 2. 1-25 lbs of weight gain during the pregnancy, 3. 26-40 lbs of weight gain during the pregnancy, 4. 41-55 lbs of weight gain during the pregnancy, and 5. More than 55 lbs of weight gain during the pregnancy. **Mother's pre-pregnancy Body Mass Index (BMI)** was calculated from three items (i.e., mother's height and mother's pre-pregnancy weight) available on the birth certificates. Next, we created 5 categories of BMI based on the Center for Disease Control and Preventions (CDC's) classifications. The five categories include, 1. BMI<18.5 (underweight), 2. BMI≥18.5 & BMI≤24.9 (Healthy Weight), 3. BMI≥25 & BMI≤29.9 (Overweight), 4. BMI≥30 & BMI≤39.9 (Obese), and 5. BMI≥40 (Class 3 Obese). **Marital status** of the mothers was dichotomized into married and unmarried based on reports at the time of birth. **Year of child birth** includes all year from 1978 to 2015. We categorized the year of birth into: 1. 1978-1977, 2. 1988-1997, 3. 1998-2007, and 4. 2008-2015.

Whether father was US born or foreign born has been assessed using birth certificate and UPDB data. Since reports on **paternal nativity** often have missing information, we include a category called "father's nativity status missing" in our father's nativity variable. **Father's education** is categorized as mother's education. Again, father's education contains a category called "father's education missing."

Results

Table 1 provides our descriptive results for the full analytical sample of singleton births in the State of Utah from 1978-2016, as well as parallel descriptive statistics for the subsamples of births of low birth weight and macrosomic births. In terms of overall sample description, while the majority of births (82%) are to US Born, Non-Hispanic Whites, significant numbers of births in the state have been to mothers with diverse national origins, racial and ethnic backgrounds. Nearly 1% of births over this period were to US born or Foreign born (FB) Pacific Islander women, and about 2% of births in the period were to US born or Foreign born Asians. The percentages of LBW and macrosomic births to subcategories of API women are widely divergent, both significantly greater than and less than the share of LBW infants born to USB NH White women (4.8%). For instance, while only 2.7% of infants born to FB Samoan women are LBW, over 10% of infants born to FB South Asian women are LBW. In terms of macrosomia, the high risks associated with PI origins are striking, as nearly 20% of FB Tongan women and 15.7% of FB Samoan women experience macrosomic births (vs. 8.7% of USB NH Whites). Notably, in the univariate view, we see that the proportion of USB PI mothers experiencing macrosomic births is substantially lower than in the FB PI populations.

[Table 1 about here]

Table 1 reveals several other patterns of association with LBW and macrosomia. LBW prevalence is greater in segments of the population with lower levels of education (the reverse is the case for macrosomia); among unmarried mothers (the reverse is the case for macrosomia); among foreign born fathers and where father's nativity is unknown (the reverse is the case for macrosomia); among births to less educated fathers (the reverse is the case for macrosomia) and where father's education is unknown; among teen mothers and mothers over 40 (results for macrosomia show a linear, positive trend with maternal age); in first births and after short birth intervals (macrosomia risks increase with longer intervals and higher parities); and in low BMI mothers with low pregnancy weight gain (the reverse is the case for macrosomia.

In Table 2 we present 6 logistic regression models, the first three predicting LBW, the latter three predicting macrosomia. Models 2a and 2d present zero order coefficients for our extensive maternal nativity and ethnicity covariate. Models 2b and 2e incorporate additional maternal health and social characteristics, and Models 2c and 2f further incorporate paternal nativity and paternal education covariates.

[Table 2 about here]

Logistic regression results reveal marked disparities in the risk of LBW and macrosomia across mothers' nativities and ethnicities. In particular, we find that the Pacific Islander mothers in our analyses (like the predominant group of Mexican origin immigrants) are less likely than native born Nonhispanic Whites to experience LBW. Here it seems the epidemiological paradox, often referred to as the Hispanic Epidemiological paradox due to robust previous findings in Latin American origin populations, does apply to Pacific Islander women. The same does not appear to hold true for many Asian origin women. While East Asian women are not significantly different from the reference group, South Asian, Southeast Asian, and Middle Eastern women experience greater odds of LBW than US Born, Nonhispanic White women.

Our data also reveal patterns of results that are generally consistent with an ill effect of acculturation upon birth outcomes. Specifically, as we see in the comparison of LBW in the Mexican, Central and South American populations versus in the US Born Hispanic population, Pacific Islander women born in the United States tend to experience greater odds of LBW than their foreign born counterparts. In contrast, and contrary to the results for LBW, the risks of macrosomia are weaker in the US Born Pacific Islander population as compared to foreign born Tongans and Samoans.

Finally, while the statistically nonsignificant coefficients for paternal nativity shown in Table 2 do not allow for a definitive statement on the impact of mother-father nativity combinations upon birth outcomes, in a supplemental analyses (results available upon request) we find that for critical national origins subsets, parenting with a native born father, as opposed to with an immigrant father, is associated with relatively adverse birth outcomes. Specifically, we find that LBW risks are greater for Mexican, Other Central American and Samoan mothers whose partners are US Born. In contrast, US Born Tongan women who parent with foreign born fathers have significantly lower LBW odds than parallel women who parent with a US born man.

Discussion

In an analysis of over 1.6 million births taking place over nearly 40 years, we find very mixed odds of LBW and macrosomia across Asian and Pacific Islander women. The main message to scholars of perinatal health, and immigrant health more broadly, is that the aggregate category of API masks dramatic variation and stands in the way of clearly understanding how nativity and acculturation influence health outcomes. Only certain API women, in particular women originating from Tonga and Samoa, see LBW odds worsen in the US Born 2+ generation. While our aggregation of US born Asians into a singular category masks internal variation, nonetheless we observe that most FB and NB Asian women experience LBW odds in excess of US Born Nonhispanic Whites. Further investigation, in particular into the factors that set apart perinatal outcomes across East Asian mothers, Middle Eastern, South Asian and Southeast Asian mothers, is necessary to provide more nuanced understanding of birth weight outcomes.

We also find (in supplementary analyses which interact maternal ethnicity-nativity and paternal nativity, that father's ethnicity often exerts a unique, significant impact upon birth outcomes. The direction of effect tends to suggest that foreign born fathering, coupled with foreign born mothering, exerts a protective effect upon birth outcomes. Although US born fathers coupled with immigrant mothers may extend formal benefits of US citizenship as well as relative status and certainty vis-à-vis social position and rights within the US context, native born fathers seem to represent a degree of acculturation that disadvantages perinatal health.

The analytical framework and methodological approach are characterized by several limitations. To begin, while birth certificate data provide an excellent resource for analysis of a full population of births, they contain significant missing data on characteristics of interest. For example, while we deem fathers' characteristics to be related both to acculturation and social status of the mothers giving birth, we are systematically missing data on many fathers' educational attainment and country of birth. Such information is particularly likely to be lacking in those cases where the mother is unmarried to the father at the time of the birth, another characteristic associated with heightened risk of LBW and macrosomia. Furthermore, birth certificates do not yield rich data for assessing acculturation, such as duration of time lived in the US. In subsequent analyses we hope to capture spatial forms of acculturation by including neighborhood level measures of ethnic diversity and other indicators. This said, the incorporate of paternal nativity is a relatively novel approach and gives insights into the wider social relations within with pregnant mothers are embedded.

These limitations aside, our analyses represent an important step toward deeper, more detailed analyses of birth outcomes as they vary across the often falsely homogenized population of Asian and Pacific Islander women. The widely variant risks of LBW and macrosomia which characterize API subpopulations suggest that approaches to health education and prenatal care which are tailored to specific national origins and ethnicities are warranted.

Table 1 Descriptive Statistics - All Singleton Births and Subsets of Births that are Low Birth Weight and Macrosomic, State of Utah, 1978-2016

	All Births		Low Birthweight (LTE 2500g)		Macrosomia (GTE 4000g)	
	Percent	N	Percent	N	Percent	N
Total	100%	1679202	5.11%	85755	8.33%	139801
National Origin/Race/Ethnicity						
Non-Hispanic White	82.40%	1383739	4.84%	66953	8.68%	120075
Mexico	4.84%	81254	5.98%	4856	6.61%	5369
Tonga	0.20%	3362	4.07%	137	19.81%	666
Samoa	0.07%	1101	2.72%	30	15.71%	173
Other Pacific Islands	0.04%	614	9.28%	57	7.82%	48
South Asia	0.15%	2521	10.08%	254	2.78%	70
South East Asia	0.55%	9261	8.21%	760	2.93%	271
Middle East	0.10%	1700	7.00%	119	5.71%	97
East Asia	0.46%	7642	5.27%	403	5.88%	449
Other Asian Countries	0.07%	1199	4.67%	56	8.42%	101
Africa	0.20%	3391	6.43%	218	6.43%	218
Europe, Canada, Australia, NZ	1.48%	24815	4.49%	1114	10.30%	2556
Other Central America	0.52%	8736	5.72%	500	5.82%	508
South America	0.74%	12462	4.54%	566	7.09%	884
African Americans	0.55%	9178	10.81%	992	3.57%	328
Native Americans	1.21%	20261	5.99%	1214	8.95%	1813
Asian	0.62%	10379	7.53%	782	4.58%	475
US born Tongan	0.07%	1240	6.37%	79	10.73%	133
US born Samoan	0.05%	786	6.36%	50	9.16%	72
US born Other Pacific Islanders	0.28%	4678	6.20%	290	7.52%	352
Hispanic	4.57%	76809	7.09%	5448	5.31%	4077
Other	0.84%	14074	6.23%	877	7.57%	1066
Mother's Education						
Less than High School	13.38%	222195	8.11%	18015	5.54%	12319
High School or GED	30.95%	514093	5.56%	28596	7.63%	39209
Greater Than High School	55.15%	916001	4.05%	37103	9.42%	86303
Unknown	0.52%	8618	8.27%	713	5.86%	505
Maternal Marital Status						
Not married	15.07%	252856	8.37%	21175	5.11%	12928
Married	84.93%	1424957	4.52%	64447	8.90%	126806
Father's Nativity						
US born	82.59%	1386774	4.69%	65049	8.72%	120942
Foreign born	9.91%	166383	5.81%	9665	7.32%	12175
Unknown father's characteristics	7.51%	126045	8.76%	11041	5.30%	6684
Father's Education						
Less than High School	8.79%	147655	7.20%	10628	6.21%	9168
High School or GED	24.56%	412393	5.71%	23552	7.43%	30635
Greater than High School	57.36%	963155	3.95%	38036	9.49%	91416
Unknown	0.47%	7863	7.11%	559	6.31%	496
Missing Father's Characteristics	8.82%	148136	8.76%	12980	5.46%	8086

Table 1 Cont. Descriptive Statistics - All Singleton Births and Subsets of Births that are Low Birth Weight and Macrosomic, State of Utah, 1978-2016

	All Births		Low Birthweight (LTE 2500g)		Macrosomia (GTE 4000g)	
	Percent	N	Percent	N	Percent	N
Mother's Age						
11-19	8.35%	140110	8.08%	11315	4.74%	6643
20-35	84.99%	1426931	4.76%	67914	8.36%	119346
36-39	5.20%	87357	5.45%	4765	12.11%	10582
40-49	1.46%	24506	7.10%	1739	13.01%	3188
Birth Interval						
No Interval	38.33%	643250	6.23%	40069	6.66%	42871
1 or less than 1	7.69%	129131	6.42%	8290	8.00%	10329
2 to 3 years	21.03%	352885	3.67%	12954	9.86%	34782
3 to 5 years	21.74%	364842	3.74%	13632	9.86%	35970
More than 5 years	11.22%	188267	5.68%	10697	8.40%	15809
Birth Parity						
No previous Preg	28.84%	484309	6.07%	29399	6.34%	30714
One to Two births	43.50%	730509	4.73%	34518	7.82%	57137
Three births	12.01%	201753	4.50%	9087	9.66%	19490
Four births	6.91%	116065	4.58%	5312	10.92%	12676
Five or more births	8.73%	146566	5.08%	7439	13.50%	19784
Prepregnancy BMI						
Underweight	4.05%	68086	9.13%	6214	2.97%	2022
Healthy BMI	35.54%	596798	5.02%	29930	6.27%	37404
Overweight	14.71%	247072	4.64%	11476	8.95%	22121
Obese	8.97%	150621	5.17%	7790	10.50%	15815
Class3 Obese	36.72%	616625	4.92%	30345	10.13%	62439
Pregnancy Weight gain						
No gain	0.63%	10606	11.03%	1170	5.31%	563
1 to 25 lb	23.70%	397934	8.36%	33255	4.85%	19303
26 to 40 lb	34.81%	584562	3.75%	21897	7.56%	44175
41 to 55 lb	10.47%	175811	2.64%	4648	12.20%	21444
More than 55 lb	30.39%	510289	4.86%	24785	10.64%	54316
Year of Birth						
1978-1987	23.44%	393635	4.73%	18612	10.44%	41098
1988-1997	22.70%	381109	5.04%	19224	8.90%	33919
1998-2007	29.37%	493250	5.27%	26005	7.27%	35877
2008-2015	24.49%	411208	5.33%	21914	7.03%	28907

Table 2. Logistic Regression Results: Correlates of Low Birth Weight and Macrosomia, Singleton Births in Utah, 1978-2016

	Model 2a	Model 2b	Model 2c	Model 2d	Model 2e	Model 2f
	LBW	LBW	LBW	Macrosomia	Macrosomia	Macrosomia
Mother's Nativity/Race/Ethnicity (ref: US Born, NH White)						
Foreign Born Mothers						
Mexico	0.223***	-0.361***	-0.426***	-0.295***	0.165***	0.192***
	-14.57	(-20.79)	(-20.87)	(-20.42)	-10.14	-10.2
Tonga	-0.180*	-0.191*	-0.244**	0.955***	0.645***	0.671***
	(-2.06)	(-2.13)	(-2.70)	-22.03	-14.32	-14.57
Samoa	-0.596**	-0.637***	-0.678***	0.674***	0.422***	0.446***
	(-3.22)	(-3.31)	(-3.52)	-8.13	-4.97	-5.23
Other Pacific	0.699***	0.295*	0.275	-0.114	0.0894	0.104
	-5.03	-2.04	-1.91	(-0.76)	-0.58	-0.68
South Asia	0.790***	0.619***	0.625***	-1.202***	-0.853***	-0.868***
	-11.92	-9.07	-9.01	(-9.91)	(-7.00)	(-7.10)
South East Asia	0.564***	0.279***	0.250***	-1.148***	-0.797***	-0.792***
	-14.82	-7.03	-6.17	(-18.60)	(-12.56)	(-12.41)
Middle East	0.392***	0.267**	0.264**	-0.451***	-0.312**	-0.324**
	-4.12	-2.75	-2.7	(-4.31)	(-2.93)	(-3.03)
East Asia	0.0907	0.03	0.04	-0.420***	-0.223***	-0.234***
	-1.77	-0.57	-0.76	(-8.62)	(-4.50)	(-4.70)
Other Asian Countries	-0.0371	-0.139	-0.152	-0.0325	0.290**	0.293**
	(-0.27)	(-1.00)	(-1.10)	(-0.31)	-2.72	-2.75
Africa	0.301***	-0.161*	-0.172*	-0.324***	-0.0512	-0.0599
	-4.29	(-2.14)	(-2.26)	(-4.63)	(-0.70)	(-0.81)
Europe	-0.0786*	-0.0454	-0.0347	0.189***	0.141***	0.134***
	(-2.54)	(-1.44)	(-1.10)	-8.97	-6.53	-6.18
Other Central America	0.177***	-0.188***	-0.221***	-0.431***	-0.162***	-0.154**
	-3.84	(-3.93)	(-4.56)	(-9.41)	(-3.46)	(-3.26)
South America	-0.0664	-0.177***	-0.183***	-0.219***	-0.0687	-0.0725*
	(-1.54)	(-4.00)	(-4.10)	(-6.25)	(-1.92)	(-2.00)
U.S. Born Mothers						
Non Hisp African American	0.869***	0.525***	0.488***	-0.942***	-0.754***	-0.733***
	-25.66	-14.86	-13.77	(-16.72)	(-13.07)	(-12.70)
Native American	0.226***	-0.0948**	-0.123***	0.0337	0.150***	0.172***
	-7.57	(-3.06)	(-3.96)	-1.36	-5.8	-6.65
Asian	0.472***	0.294***	0.289***	-0.684***	-0.505***	-0.509***
	-12.61	-7.5	-7.35	(-14.53)	(-10.50)	(-10.55)
US born Tongan	0.291*	0.272*	0.226	0.235*	0.05	0.0785
	-2.5	-2.3	-1.91	-2.55	-0.53	-0.83
US born Samoan	0.290*	0.188	0.156	0.0594	0.02	0.0444
	-1.98	-1.25	-1.05	-0.48	-0.16	-0.35
US born other Pacific Islanders	0.262***	0.0932	0.0585	-0.155**	-0.153**	-0.133*
	-4.32	-1.5	-0.94	(-2.79)	(-2.70)	(-2.34)
Hispanic	0.406***	0.0578***	0.0303	-0.528***	-0.267***	-0.252***
	-27.83	-3.73	-1.93	(-32.23)	(-15.78)	(-14.72)
Other	0.268***	0.0233	0.00226	-0.148***	-0.0963**	-0.0896*
	-7.63	-0.56	-0.05	(-4.62)	(-2.58)	(-2.39)
Mother's Age (ref: Less than 20)						
"20-35"		0.0167	0.0394**		0.124***	0.107***
		-1.26	-2.98		-8.33	-7.15
"36-39"		0.210***	0.242***		0.324***	0.302***
		-9.79	-11.28		-17	-15.77
"40-49"		0.410***	0.438***		0.395***	0.374***
		-13.46	-14.4		-15.48	-14.63
Year (Decadal) (reference: 1978-87)						
"1988-97"		-0.131***	-0.141***		0.345***	0.349***
		(-7.64)	(-8.22)		-29.51	-29.85
"1998-2007"		-0.0628***	-0.0749***		0.170***	0.175***
		(-3.33)	(-3.97)		-12.14	-12.43
"2008-2015"		0.0396*	0.0409*		0.0191	0.0164
		-2.06	-2.13		-1.33	-1.14
Number of Previous Live Births (ie Parity)) (Ref: Zero previous births)						
One to Two		0.0780***	0.0719***		0.126***	0.129***
		-6.23	-5.74		-10.81	-11.04
Three		0.0754***	0.0729***		0.313***	0.312***

Table 2 Cont. Logistic Regression Results: Correlates of Low Birth Weight and Macrosomia, Singleton Births in Utah, 1978-2016

	Model 2a	Model 2b	Model 2c	Model 2d	Model 2e	Model 2f
	LBW	LBW	LBW	Macrosomia	Macrosomia	Macrosomia
		-4.55	-4.4		-22.46	-22.37
Four		0.0877***	0.0887***		0.413***	0.410***
		-4.58	-4.63		-27.25	-27.01
Five or more		0.146***	0.148***		0.583***	0.578***
		-8.05	-8.13		-40.24	-39.89
Birth Interval (Ref: NA, First birth)						
1 or less than 1 year		-0.103***	-0.106***		-0.0405**	-0.0393**
		(-6.54)	(-6.71)		(-2.80)	(-2.72)
2 to three years		-0.577***	-0.568***		0.151***	0.146***
		(-41.13)	(-40.44)		-13.07	-12.64
3 to 5 years		-0.565***	-0.557***		0.148***	0.145***
		(-40.66)	(-40.10)		-12.93	-12.6
more than 5 years		-0.235***	-0.240***		-0.0214	-0.017
		(-15.82)	(-16.15)		(-1.63)	(-1.29)
Mother's Education (Ref: Some college and higher)						
Less than High School		0.569***	0.409***		-0.446***	-0.349***
		-47.36	-30.76		(-37.46)	(-26.79)
High school or GED		0.273***	0.165***		-0.238***	-0.172***
		-31.75	-17.2		(-35.37)	(-23.18)
Unknown Education		0.437***	0.318***		-0.234***	-0.216**
		-10.18	-5.68		(-4.86)	(-3.26)
Pregnancy Weight gain (Ref: 1-25 pounds)						
No gain		0.390***	0.379***		-0.148***	-0.142**
		-12.06	-11.7		(-3.31)	(-3.18)
26 to 40		-0.902***	-0.897***		0.633***	0.630***
		(-97.35)	(-96.84)		-68.74	-68.46
41 to 55		-1.350***	-1.350***		1.247***	1.246***
		(-83.01)	(-82.98)		-115.43	-115.4
More than 55		-0.645***	-0.650***		1.030***	1.032***
		(-41.63)	(-41.90)		-80.32	-80.46
Prepregnancy BMI (Ref: Healthy BMI)						
Underweight		0.564***	0.563***		-0.682***	-0.680***
		-37.63	-37.53		(-29.11)	(-29.04)
Overweight		-0.209***	-0.219***		0.457***	0.463***
		(-18.06)	(-18.93)		-50.43	-51.02
Obese		-0.295***	-0.315***		0.792***	0.804***
		(-21.52)	(-22.93)		-74.98	-75.97
Class3Obese		-0.0637***	-0.0738***		0.307***	0.311***
		(-4.80)	(-5.57)		-27.41	-27.65
Mother's Marital Status (Ref: Unmarried at time of birth)						
Married at time of birth		-0.360***	-0.236***		0.270***	0.199***
		(-36.02)	(-19.18)		-25.08	-14.88
Father's Education (Ref: Some college and higher)						
Less than High School			0.336***			-0.186***
			-22.89			(-13.22)
High school or GED			0.227***			-0.150***
			-22.65			(-18.77)
Unknown Education			0.175**			-0.0268
			-2.91			(-0.40)
Missing Father's Characteristics			0.387***			-0.168***
			-16.25			(-6.81)
Father's Nativity (Ref: Father US Born)						
Foreign born			0.0129			0.00644
			-0.86			-0.51
Missing Father's Characteristics			-0.0158			-0.0427
			(-0.70)			(-1.80)
Intercept	-2.979***	-1.998***	-2.174***	-2.354***	-4.004***	-3.898***
	(-751.93)	(-81.77)	(-84.16)	(-779.40)	(-174.66)	(-158.72)
N	1679202	1658502	1658502	1679202	1658502	1658502

t statistics in parentheses

="* p<0.05 ** p<0.01 *** p<0.001"

Source: Utah Population Database

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