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A Secondary Analysis of Race/Ethnicity and other Maternal Factors Affecting Adverse Birth Outcomes in San Bernardino County

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Abstract

Objectives—Though it is the largest county in the lower United States, minimal attention has been given to the elevated rates of poor perinatal outcomes and infant mortality in San Bernardino County. This study sought to analyze adverse birth outcomes such as low birth weight, and infant mortality as an outcome of specific proxy maternal sociodemographic factors.

Methods—Data from the California Department of Health Services Office of Vital Statistics birth cohort of mothers delivering between 1999 and 2001 ($N = 1,590,876$ participants) were analyzed. Of those, 5.5% ($n = 86,736$) were births in San Bernardino County. Low birth weight, very low birth weight, death in infants less than one year of age, and other maternal sociodemographic factors were explored. All events of low birth weight and deaths among infants less than one year of age were used as significant variables in statistical models.

Results—Black mothers experienced more than twice the rate of very low birth weight (3.89) than their White counterparts (1.39). The most significant contributors to adverse birth outcomes among Black women were length of gestation and maternal education, whereas the most significant predictor of infant mortality was birth weight.

Conclusions—This study demonstrates that traditional risk factors such as length of gestation and maternal age only partially explain adverse birth outcomes. These findings highlight the need to advocate for the systematic collection of data on maternal education and length gestation and for the promotion of public health initiatives that address these inequities in our most vulnerable of populations.

Keywords

Moderately low birth weight; Very low birth weight; Low birth weight; Infant mortality; Birth outcomes; Health disparities; San Bernardino County

Introduction and Purpose

It has been firmly established that infant birth weight is not only a primary determinant of infant mortality, but that the one percent of very low birth weight occurrences (<1,500 g) accounts for more than half of all neonatal deaths and 63% of the Black-White gap of US infant mortality [1, 2]. Healthy People 2010 [3] objectives include reducing the infant mortality rate to no more than 4.5/1,000 live deliveries, a reduction in incidence of

moderately low birth weight (<2,500 g) to 5.0% and a reduction in incidence of very low birth weight babies (<1,500 g) to 0.9% [4]. The gap refers to the persistently increasing disproportionate rates of moderately low birth weight, very low birth weight and infant mortality between Black and White mothers. Though notable progress has been made in reducing infant mortality rates in the United States, the gap between Black and White infants continues to necessitate practical and culturally appropriate public health intervention programs. Even after adjusting for several factors, such as maternal age at birth, education, income and marital status, a Black infant is more than twice as likely to die within the first year of life as his or her White counterpart [2].

Research studies have associated moderately low and very low birth weights with numerous health conditions. These infants who survive into adulthood may develop metabolic and chronic disease complications later in life. A child born at a moderately low or very low birth weight, and who lives beyond his or her first birthday, is at an increased risk for developing metabolic and chronic disorders, such as Type II diabetes, coronary heart disease, stroke, hypertension, and prostate cancer [5–7]. Further, infants born at very low birth weight (<1,500 g) face impairments in normal physical and cognitive development [8] and are at a considerably higher risk of dying within the first year of life than their moderately low birth weight (1,500–2,499 g) counterparts. In addition to higher occurrences of disease in adulthood, adverse birth outcomes and infant mortality costs the nation 10% of all national child healthcare costs, and in 1998, the total lifetime costs of one premature infant was conservatively estimated at \$500,000 [9].

Though San Bernardino County has consistently reported one of the highest infant mortality and low birth rates in California for the past several years, minimal research has been conducted in this area [10]. Given that San Bernardino is the largest geographical county in the lower 48 states and is home to the fourth largest population in California, the need for more research within the area of adverse birth outcomes is critical. The racial and ethnic disparities observed in poor birth outcomes warrant comprehensive inspection into their root causes. Accordingly, this research sought to better understand the dynamics of maternal, infant and child health issues in San Bernardino County; to demonstrate that traditional risk factors only contribute partially to adverse birth outcomes; and to describe some of the health disparities that disproportionately affect racial and ethnic minority populations of San Bernardino County.

Methods

The present study adopted the 1984 Mosley-Chen framework for analysis of mortality, a model used by some researchers to examine adverse birth outcomes and infant mortality [11]. The framework states that underlying socioeconomic status is rooted in measurable determinants, and the values of these variables ultimately influence the risk of disease, which are linked to the probability of death [12]. An expanded application of the framework examines socioeconomic status jointly with sociodemographic factors, such as education, primary source of insurance, number of previously delivered infants, marital status and infant exposure to environmental tobacco smoke. A combination of these factors leads to more debilitating states of health, and consequently, differences among ethnic populations should be expected.

Study Design and Participants

This study used public data from the California Department of Health Services, Office of Vital Statistics, Health and Welfare Agency Department. These public data represent the California Birth Cohort Files. The birth cohort files contained archived, maternal population-based data, which included all women who delivered between 1999 and 2001 in

California. The data set included 1,509,876 participants, of which 86,736 participants delivered in San Bernardino County represented 5.5% of the total cohort.

The information in these files was compiled from retrospective data collected in California via hospital records of live births. Birth, infant and fetal deaths were obtained via an electronic statewide registration process where birth certificates were generated through data entered into the Automated Vital Statistics System (AVSS) at either the birth hospital or local birth registrar. Death records of infants who died within their first year of life were matched and linked to respective live birth records in the birth cohort file. All events of moderately low and very low birth weight, as well as deaths among infants less than one year of age were used as significant variables in statistical models. Fetal deaths included stillborn babies, and infant death included premature births or those infants who died within the first year of life. For additional information about these files, please visit the California Department of Health Services webpage (www.dhs.ca.gov).

Study Measures

The independent variables included in the analysis were taken from the birth record certificate and included: mother's self-identified race/ethnicity; maternal education; marital status; maternal age at time of delivery; primary source of income; maternal birth country; month prenatal care began (as a confounding variable); gestational age; birth order of infant; total number of children born alive; sex of child; and smoking status of the mother. The dependent variables included in the analysis were: length of gestation; maternal age at time of delivery; fetal event (the outcome was life or death); primary pregnancy complication; and birth weight at time of delivery.

The age at time of delivery is defined by the mother's age, and infant mortality refers to infants' survival beyond the first year of life; these factors were recorded as a binary yes/no variable. Birth weight was entered as a continuous variable in the raw data set, and then recoded into the following categories: very low birth weight (<1,500 g), moderately low birth weight (1,500–2,499 g), normal birth weight (2,500–3,999 g) and macrosomic birth weight ($\geq 4,000$ g). Normal birth weight was used as the referent category when comparing across different birth weight groups. Maternal education was also categorized to reflect the following: primary education (0–4 years); some secondary education (5–8 years); high school education (9–12 years); college education (13–16 years); graduate level and above (17+ years); and unknown educational status.

Data Analysis

All analyses performed in the study addressed the correlates and associations of adverse birth outcomes in San Bernardino County. Statistical analysis, simple frequency tabulations, and descriptive analyses were performed before any bivariate or multivariate analyses occurred, while univariate analysis was performed to assess each variable separately to check for ranges of observations, distribution, etc.

Results

Table 1 includes descriptive analyses for the most important variables in the study. Simple tabulations, means, and standard deviations were calculated. The numbers and rates for infant mortality, moderately low and very low birth weight rates have been included. Given the large sample, all P-values were statistically significant. Of the 86,736 women who delivered in San Bernardino County, Whites constituted 32.3% of the sample; Blacks, 9.4%; Hispanics, 7%; and women of other races, 5.7%. The percentage of Black and Hispanic mothers was statistically higher in San Bernardino County than in California ($P < 0.001$).

The majority of births during this interval occurred among mothers of Hispanic descent, comprising 48.5% and 52.7% of total deliveries in California and San Bernardino County, respectively.

Infant mortality rates in San Bernardino County were higher than rates for California, with Black infants having a 12.6% higher rate than Blacks throughout the rest of California. Within San Bernardino County, the infant mortality rate for Black infants was more than double Hispanic or White infants, which is comparable to state data. The mean age of San Bernardino County females in this cohort was 26.5 years while the mean age in California was 27.8. The mean birth weight of babies was lowest in Black mothers in California and San Bernardino County (3145.0 g, 3111.6 g, respectively) and highest among White infants (3412.0 g, 3376.6 g, respectively). The total crude mean birth weight for California and San Bernardino County was 3347.5 g and 3326.0 g, respectively.

Table 2 reports the results of multiple regression analysis on outcomes for Black mothers, and is used to identify the factors which contributed most significantly to moderately low and very low birth weights. Tables 2 and 3 highlight the significant predictors in the multiple and logistic regression models. Correlations between specified sociodemographic factors and predictors of adverse birth outcomes among Black mothers were also ascertained; maternal age, education, insurance and length of gestation were all statistically strong contributors to events of moderately low and very low birth weight. Smoking during pregnancy was not found to have as strong an association with low birth weight. There were strong correlations between birth weight and length of gestation (.374, $P < 0.001$); maternal age and maternal education (.345, $P < 0.001$); and insurance status and maternal education (.239, $P < 0.001$).

Table 3 is a summary of the results of infant death among Black mothers after logistic regression analysis was performed. In this table, very low birth weight and moderately low birth weight are considered high risk factors in infant death. For moderately low birth weight, the odds ratio was 200% (OR = 3.00) higher than the referent normal birth weight category. Very low birth weight was more than 2800% (OR = 28.70) higher than the referent category, while macrosomic birth weight ($\geq 4,000$ g) was a protective category, but not a significant predictor. Similarly, length of gestation was also a significant predictor of infant death among Black women in San Bernardino County. In Table 3, logistic regression for Black infant death was performed. Parameter estimates and odds ratios have been included. Dummy variables were created for birth weight categories. Referent categories for marital status and birth weight were “married” and “normal birth weight” (2,500–3,999 g).

In Table 4, differences in lower age groups at time of delivery (15–19 years of age) were examined. ANOVA and chi-square analyses were performed. Corresponding P-values for the birth weight categories and the infant mortality chi-square P-value have been recorded. Total count and percentage of the population by race/ethnicity have also been included. Table 4 shows that infant death between mothers of the same age category (≤ 19 years of age) did not statistically differ with respect to race. The birth weight P-value shows that there is a significant difference among mothers within the same category. Overall differences in mean birth weights between mothers less than or equal to 19 years of age and those above 19 years of age were also highly significant. The results suggest that women of younger age groups have more adverse birth outcomes, particularly low birth weight, than women of higher age strata.

Discussion

We sought to examine adverse birth outcomes as an outcome of specific proxy maternal sociodemographic factors for San Bernardino County. Maternal demographics within the County were far different from those in greater California. The age at which mothers deliver babies, for instance, was younger among San Bernardino County women. Further, San Bernardino County has a higher proportion of Black and Hispanic women compared to the rest of California. Most importantly, there are higher rates of infant mortality, moderately low birth weight and very low birth weight in San Bernardino County than California as a whole.

To date, no work has been performed with this amount of detail in San Bernardino County. However, the need for exploration has only intensified over the past decade. The need for more appropriate prevention at both the public and practitioner level is evident, as rates by geographic location display a wide range. This study demonstrates that infant morbidity in the forms of moderately low and very low birth weights, infant mortality and other sociodemographic factors are attached to multiple maternal risk factors, which contribute to the incidence of poor birth outcomes. Moreover, our results corroborate other research that poor birth outcomes are only partially explained by traditional risk factors, such as length of gestation, maternal age, education at time of birth, etc. According to Alexander and Kogan [13] observed disparities between Black and White infant mortality and poor birth outcomes have been largely attributed to factors including, but not limited to, socioeconomic status, health care use, maternal demographic information, environmental conditions, behavioral and medical risk characteristics [14] but these indicators only partially explain why Black infant mortality rates are more than twice the rate of their White counterparts [15, 16].

Smoking has consistently been shown in the literature to be one of the strongest determinants in assessing birth outcomes. This study was not able to confirm existing findings. However, we purport that this may be a reflection of the limitation stemming from the methodology used to collect and code the smoking variable. Smoking was recorded as a complication of pregnancy, which made it a less reliable measure.

The findings of health disparities among the most vulnerable of populations warrant the need for immediate intervention. Teenage pregnancy alone fosters elements of low academic achievement typically because the mother is often unable to complete secondary education, poor maternal and child health (due to lack of preparation and life experiences) which is again, repeated intergenerationally.

Research over the past decade has suggested that the differences in perinatal outcomes for Black babies may be a result of inequities in health care [17]. According to the literature, foreign-born Asian and Mexican women have markedly lower rates of moderately low and very low birth weight and have infant mortality rates comparable to White women [15].

Conclusion

The ability to introduce prevention programs that will help enhance the quality of life for women throughout San Bernardino County will ultimately decrease rates of overall poor birth outcomes. Establishment of preventive measures should occur at the levels likely to have the most significant impact. It is vital that public health officials and key leaders recognize those populations and areas most adversely impacted by the lack of provision of services, as efforts that may have the potential to reduce poor birth outcomes should be redirected to these regions. Further investigation should be performed on these populations to reduce ethnic and geographic birth outcome disparities. By understanding which factors contribute most significantly to those rates in San Bernardino County, clinicians, public

health officials and individuals may be better equipped to reduce the likelihood of infant mortality and poor birth outcomes.

Traditional maternal risk factors alone cannot explain some of those outcomes observed in this study. The health disparities in perinatal outcome findings among different racial/ethnic groups confirm the need for additional research and the provision of more culturally appropriate and culturally relevant reproductive and maternal and child health programs. Policy to reduce fertility through reproductive health efforts or via the provision of appropriate and reliable medical care will reduce the incidence of infant mortality [18]. More innovative approaches to current programs are necessary in further elucidating causal factors that may be responsible for elevated rates of moderately low birth weight, very low birth weight, and infant mortality in San Bernardino County. Those initial efforts must be re-evaluated to decrease the elevated rates of poor birth outcomes in San Bernardino County.

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Table 1

Maternal demographic characteristics between California and San Bernardino County, 1999–2001

	California N = 1,504,140		San Bernardino County N = 86,736	
	Mean ± SD	Median	Mean ± SD	Median
Birth weight (g)				
White	3,412.0 ± 618.1	3,459	3,376.6 ± 610.2	3,416
Black	3,145.0 ± 718.8	3,224	3,111.6 ± 703.8	3,203
Hispanic	3,359.0 ± 598.6	3,393	3,342.5 ± 698.7	3,374
Other	3,239.0 ± 587.3	3,260	3,247.2 ± 588.8	3,282
Overall	3,347.5 ± 616.1	3,380	3,326.0 ± 617.0	3,370
Age (in years)				
White	29.6 ± 6.30	30	27.2 ± 6.15	27
Black	26.5 ± 6.71	26	25.6 ± 6.45	24
Hispanic	26.3 ± 6.21	26	25.9 ± 6.19	25
Other	29.9 ± 6.12	30	29.4 ± 6.66	29
Overall	27.8 ± 6.48	28	26.5 ± 6.30	26
Length of gestation (days)				
White	277.0 ± 31.25	277	276.9 ± 34.40	277
Black	272.7 ± 34.59	276	272.4 ± 38.14	275
Hispanic	276.2 ± 28.34	277	276.0 ± 31.25	276
Other	275.1 ± 25.08	276	275.2 ± 32.44	275
Overall	276.1 ± 29.38	277	275.9 ± 33.07	276
	Number	Rate	Number	Rate
Infant mortality rate				
White	2,401	4.9	194	6.9
Black	1,171	12.5	117	14.3
Hispanic	3,985	5.5	290	6.3
Other	1,039	5.3	35	7.1
Moderately low birth weight rate				
White	23,183	4.8	1,386	5.0
Black	8,388	9.0	737	9.1
Hispanic	33,715	4.6	2,108	4.6
Other	11,664	6.0	279	5.7
Very low birth weight rate				
White	6,420	1.3	388	1.4
Black	3,407	3.6	317	3.9
Hispanic	9,807	1.4	69	1.5
Other	2,741	1.4	82	1.7

Table 2

Multiple regression analysis of maternal factors contributing to moderately low and very low birth weight among Black mothers in San Bernardino County

	Parameter estimate	95% CI	P-value
Intercept	952.2		<0.001
Length of gestation	6.81	(6.42, 7.19)	<0.001
Maternal education	59.17	(32.18, 86.17)	<0.001
Maternal age	12.95	(-9.01, 34.91)	0.248
Insurance	-17.30	(-39.17, 4.58)	0.121
Smoking during pregnancy	58.93	(-18.81, 136.67)	0.137

Table 3

Summary of factors contributing to Black infant death in San Bernardino County

	Parameter estimate	Odds ratio	95% CI	P-value
Intercept	-1.93			0.081
Birth weight				
Normal birth weight	Referent			
<1,500 g	3.36	28.70	(12.99, 63.41)	<0.0001
1,500–2,499 g	1.10	3.00	(1.40, 6.44)	0.005
≥ 4,000 g	-0.33	0.72	(0.10, 5.35)	0.749
Maternal education	0.01	1.01	(0.99, 1.06)	0.202
Previous infant death	-0.03	0.97	(0.76, 1.24)	0.808
Maternal age	-0.02	0.98	(0.94, 1.01)	0.230
Length of gestation	-0.01	0.99	(0.98, 1.00)	0.001
Insurance	-0.01	0.99	(0.95, 1.03)	0.559
Marital status				
Married	Referent			
Unmarried	0.05	1.05	(.65, 1.69)	0.848

Table 4

Significant differences in adverse pregnancy outcomes by mothers less than 19 years of age in San Bernardino County

	White Mean \pm SD/Count (%)	Black Mean \pm SD/Count (%)	Hispanic Mean \pm SD/Count (%)	P-value
Total count	2,960 (10.6%)	1,455 (17.9%)	7,370 (16.1%)	
Birth weight (in grams)	3,298.4 \pm 584.85	3,085.7 \pm 647.78	3,248.3 \pm 575.86	<0.0001 **
<1,500 g	46 (1.6%)	45 (3.1%)	115 (1.6%)	<0.0001 *
1,500–2,499 g	155 (5.2%)	118 (8.1%)	413 (5.6%)	
Infant mortality rate	24 (0.81%)	15 (1.03%)	58 (0.79%)	0.640 *

* Chi-Square P-value

** ANOVA P-value