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Predictors of Preterm Birth in New Mexico: outcomes from 377,770 pregnancies over fifteen years

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Background: Preterm birth (PTB) is a significant health problem both in New Mexico and nationally. It accounts for significant infant morbidity and mortality and it poses an economic burden to both individuals and the state. The goal of this study is to elucidate maternal risk factors for PTB in New Mexico, a poor state with a unique ethnic background. By doing this we hope to be able to identify women at increased risk and invite further study into targeted interventions among these high risk populations.

Methods: This was a cross-sectional analysis of 377,770 singleton live births in the state of New Mexico from 1991-2005. The medical risk factors tracked were pulmonary, renal, cardiac, diabetes, eclampsia, oligo/polyhydramnios, hypertensive disorders, cervical incompetence, previous preterm delivery, tocolysis and isoimmunization. Gestational age of less than 37 weeks was defined as PTB. Multiple gestations and congenital anomalies were excluded. The Kotelchuck Index was used as a measure for level of prenatal care described as inadequate, intermediate, adequate, and intensive. Multivariate logistic regression was conducted using SAS 9.1 statistical software.

Results: Of the live births analyzed, 28,036 of these were preterm (7.4%). Overall the PTB rate has risen from 1991-2005 at a rate of 0.18 percent per year. This was statistically significant ($p = <0.00004$). Among patients with medical risk factors, PTB rate had a direct inverse relationship with an intensive level of prenatal care. High risk patients with intensive care were less likely to have a PTB delivery with an odds ratio of 0.74 than similar patients with low levels of care. The nadir for risk of PTB is among women aged 25-29 with significant increases in risk among women <15 and >40 years of age. Other risk factors are unmarried status, education less than high school, tobacco/alcohol use, Black, Asian, and White Hispanic ethnicity and the presence of one or more medical risk factors. Statistically significant protective factors for PTB are age 25-29, education surpassing high school, and Native American race. Counties with rising adjusted PTB rates are Chaves, Dona Ana, Grant, Hidalgo, Lea, Lincoln, McKinley, Mora, Otero, Rio Arriba, San Juan and San Miguel. Counties with decreasing PTB rates are Sandoval and Santa Fe counties.

Conclusion: Even adjusted for known risk factors PTB is still a significant problem in New Mexico. A lack of prenatal care was a significant predictor of PTB in high risk patients. Other predictors include the known risk factors of age <15 and >40, single, tobacco/alcohol use, being of low socioeconomic status and White Hispanic, Asian and Black ethnicities. Interestingly, Native American patients have a lower PTB rate compared to other groups, even though this group is traditionally one of low socioeconomic status in New Mexico.

Background

Preterm birth (PTB), defined as birth before 37 weeks gestational age, is a significant health problem, both in New Mexico and nationally. Infants born preterm accounted for 10.8% of the total births in NM in 2004, which was an increase from 10.1% in 2003.[1] In the United States, disorders associated with prematurity account for the leading cause of death during the neonatal period (birth to 28 days) and is second only to congenital malformations as the major cause of death during infancy (birth to one year).[2] In New Mexico disorders associated with prematurity were the leading cause of death in infancy in 2004.[3]

Encouragingly however, infant mortality in the United States has decreased significantly between 1950 and 2001, which has been partially linked to advances in health care[4] Due to these advances in neonatal medicine, an infant born at 36 weeks or greater has the same survival rate as a term infant, and those infants born at 32 to 35 weeks have a 98% survival rate as compared to a term infant. Those born at 28 to 31 weeks have a 90-95% survival rate, but for infants born less than 28 weeks the survival rate drops sharply. Infants born less than 22 weeks are not considered viable.[5]

Nonetheless, even with a decreased risk of infant mortality due to short gestation, the incidence of morbidity among this population remains high. Premature infants have more severe jaundice, anemia, patent ductus arteriosus and infections than their full term counterparts. There are also conditions that are typically limited to premature infants, such as retinopathy of prematurity (ROM), respiratory distress syndrome (RDS), bronchopulmonary dysplasia (BPD), apnea of prematurity, intraventricular hemorrhage (IVH), necrotizing enterocolitis (NEC) and gastroesophageal reflux (GERD). Some of these conditions can lead to lifelong disabilities.[5]

In addition to the mental, physical and emotional costs associated with PTB, premature infants create many financial costs, both to individual families and to society. In 2003 in the United States, half of all hospital charges for newborns were for infants with the diagnosis of PTB or low birth weight. These costs totaled almost 18.1 billion dollars.[6] The economic burden of preterm birth is even greater when one considers maternal hospitalization. It has been estimated that preterm birth costs society about 26 billion dollars each year.[7]

The causes of preterm labor are multifactorial and all of the causes have not yet been made clear. In about 20% of cases, preterm labor is iatrogenic.[8] Some examples of this are preeclampsia, the related HELPP syndrome, placental abruption or intrauterine growth restriction.[9] However, the majority of preterm labor occurs spontaneously. Although many factors that predispose to preterm labor and/or birth have yet to be discovered, there are many risks that have been elucidated. One of the strongest risk factors for preterm delivery is a history of preterm delivery. This has led researchers to postulate that there might be a genetic component to preterm delivery. Maternal race has also been shown to be a factor in preterm delivery. However, it is not known if race is an independent risk factor for preterm delivery (perhaps due to a genetic component) or if it is a risk marker for chronic emotional, economic and social stresses that could in themselves cause an increase in preterm delivery. Most research in the United States has focused on the higher risk of preterm birth among black women as opposed to white women. However, in the United States from 2001 to 2003 the most remarkable increases in preterm birth were among non Hispanic whites, Hispanic, and Native American ethnicities.[7]

Multifetal gestation, cervical procedures (such as conization surgery) and uterine malformations are also risk factors for PTB. Maternal use of tobacco products, cocaine, and alcohol all confer risk. Another risk factor for PTB is maternal age. There have been many studies that have shown that maternal age of less than 18 years increases the risk of PTB before the age of 32 weeks compared to 25 year old mothers. The research is less clear regarding the association between PTB and advanced maternal age. Increased risk of PTB has also been suggested for women with decreased interpregnancy periods, increased work hours, history of an induced abortion and maternal periodontal disease but the literature is conflicting.[10]

In addition to these risk factors, another association that continues to be explored is the relationship between socioeconomic status and PTB. This has been complicated by the fact that socioeconomic status can be defined in many ways, including maternal or paternal education level, employment, and income level.[11] Many studies have shown an association between socioeconomic status and the risk of either low birth weight or preterm birth. One study done in Quebec demonstrated that although both maternal

income and education contributed to increased risk, it was education level that imparted the greatest increased risk of negative pregnancy outcomes.[12] Another study conducted on white subjects in the UK showed an increased risk of preterm birth with lower income, education level, lower social class, and unmarried status.[13] An additional study showed that there is an increased risk for preterm birth in black women identified as "poor" or "near poor". White women in the "near poor" category also had an increased odds ratio for preterm birth.[14] A study of black women in the United States showed that among low income women there was a positive association between preterm birth and having inadequate time and/or finances for non essential items.[15] A further study has also demonstrated that black women living in higher income tracts have a decreased risk of PTB.[16] However, one study done in the United States suggested that black women who live in wealthier neighborhoods where they are the racial minority may actually have worse pregnancy outcomes than their counterparts who live in neighborhoods where they are in the racial majority. In the study this was attributed to the emotional stress of their living situation.[17] Out of all the socioeconomic indicators however, it has been asserted that education level is one of the most sensitive in observing differences.[11]

New Mexico is a state with a premature birth rate that exceeds the national average. It also has a high proportion of potential socioeconomic risk factors for preterm birth. Its median household income in 2005 ranked forty-forth nationally and in that same year 18.5% of its population lived below the poverty level. The state also ranked forty-first in terms of people over the age of 25 with a high school diploma. Furthermore, New Mexico has a unique ethnic and racial profile. Forty-three point five of its residents are non-Hispanic white, 41.5% are Hispanic, and 11% are Native American. Only about 4% of its residents are black or of Asian descent.[1] Therefore, the factors that influence the incidence of preterm birth in New Mexico are likely to be unique to this region due to its distinctive composition.

Methods

Birth data from 1991-2005 was obtained from the New Mexico Department of Health Bureau of Vital Records and Health Statistics. There were 423,612 births recorded during this 15 year time frame. The individual data that was analyzed included

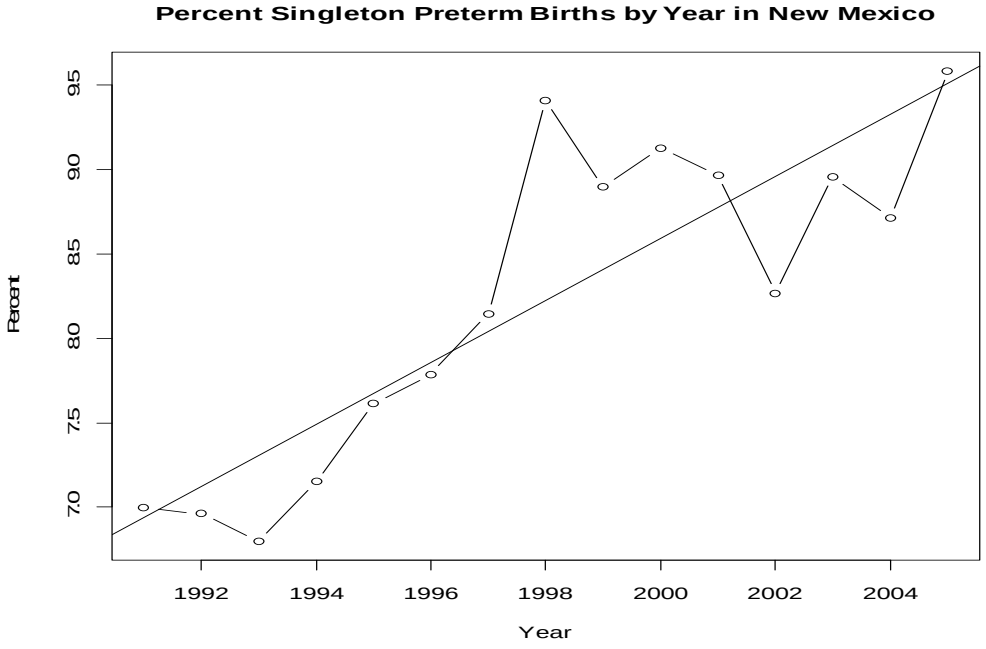
rates of preterm birth, which was defined as gestational age of less than 37 weeks but greater than 22 weeks, level of prenatal care utilization, maternal ethnicity, maternal age, maternal education level, marital status, tobacco or alcohol use during pregnancy, county of maternal origin, birth year, and high vs. low risk pregnancy. All variables were adjusted for one another in this analysis. Level of prenatal care utilization was calculated utilizing the Kotelchuck index.[18] Maternal ethnicity was categorized as Asian, White non-Hispanic, White Hispanic, Native American, Black or other. Facility types were hospital, birth center, home or other. For simplicity of analysis maternal age was divided into less than 15, 15-19, 20-24, 30-34, 35-39 and greater than 40. We used maternal education level as a surrogate of maternal socioeconomic status (SES), since maternal household income was not available from the database utilized, and because it has been shown to be a good indicator of SES, as previously discussed. Maternal education level was divided into less than 9 years of education, 9-12 years of education, between 13 and 16 years of education, and greater than 16 years of education. In New Mexico this would be equivalent to: no high school, some high school, at least some undergraduate education, and at least some graduate level education. Amount of tobacco or alcohol consumption was not available through the database, so these data were analyzed as simple dichotomous variables. A pregnancy was considered high risk if there was a maternal condition that could have contributed to an increased risk for preterm birth (see Table 1). Given that this analysis is focused on maternal risk factors, fetal conditions that could have contributed to preterm birth such as congenital and chromosomal anomalies that could have contributed to preterm birth were excluded. With these exclusions, 377,770 individual birth data were analyzed using SAS Version 9.1.[19] We used logistic regression to perform this multivariate analysis. This study was exempted from review by the Human Research Review Committee of the University of New Mexico.

Table 1 Maternal conditions considered high risk
Diabetes
Eclampsia
Pregnancy Induced Hypertension (PIH)
Chronic Hypertension (cHTN)
Oligohydramnios
Incompetent Cervix
Previous premature delivery
Rh sensitization
Lung Conditions
Cardiac conditions
Renal Conditions
Other medical risk factor not otherwise specified

Results:

Overall, there were 377,770 total births included for analysis. Of these, 28,036 births were classified as preterm, which was 7.4% of births evaluated. Overall, preterm birth did have a statistically significant trend upward of 0.18 percent per year over this 15 year period (see Figure 1).

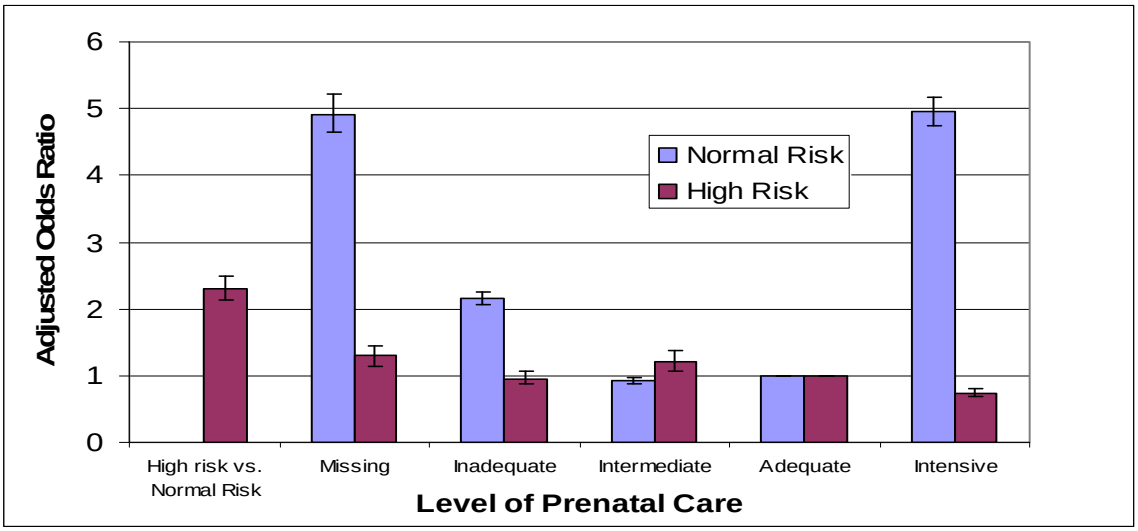
Figure 1



Women who had missing, inadequate and intensive levels of prenatal care per the Kotelchuck index had an increased risk of having a preterm baby as compared to women with an adequate level of prenatal care. Interestingly, patients with an intermediate level of prenatal care had a slightly reduced risk of preterm birth (See Figure 2).

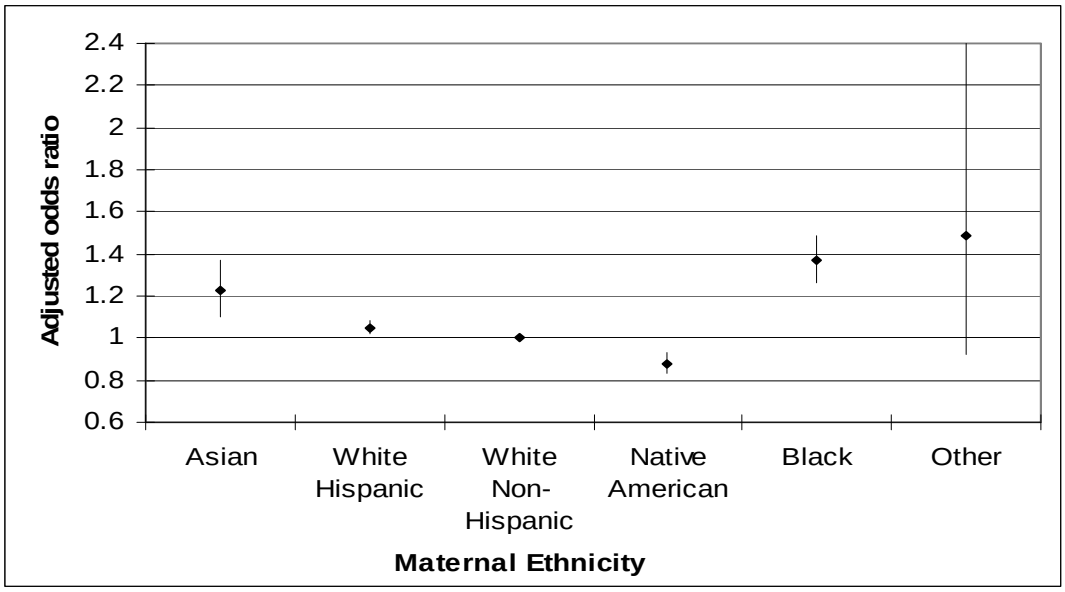
Not surprisingly, those women with medical risk factors for preterm birth had a statistically significantly higher risk of having a preterm baby (OR 2.31; 95% CI 2.14-2.48; p <0.001). However, of those women with medical risk factors, those women who had missing or intermediate levels of prenatal care had an increased risk of having a preterm baby compared to those high risk women with adequate care. Women who received intensive care during their high risk pregnancy had a statistically significant decrease in their probability of preterm birth (See Figure 2).

Figure 2: Adjusted odds ratio of Preterm Birth with Medical Risk factors interacted with level of prenatal care.



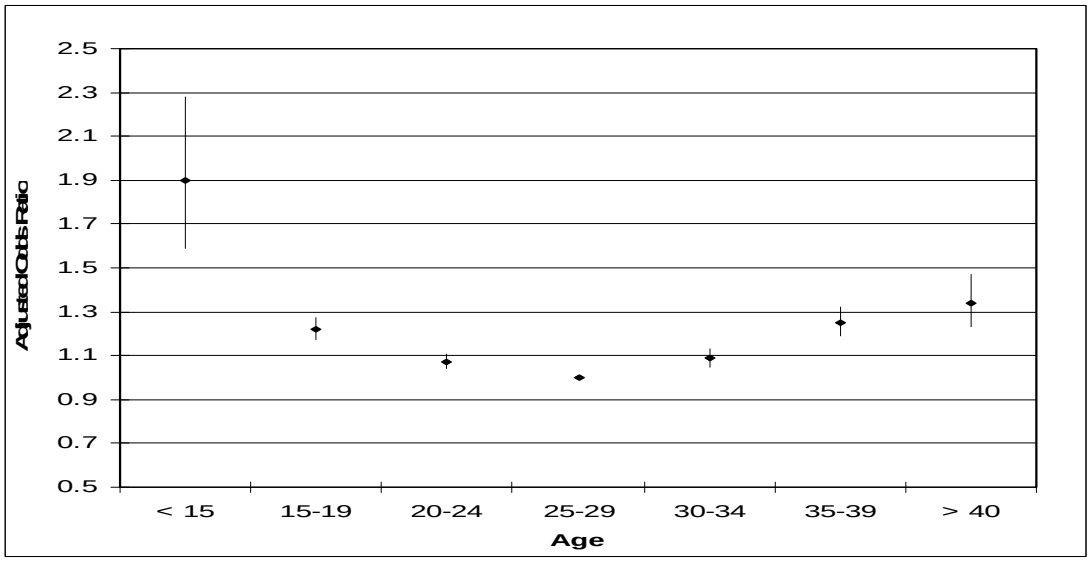
Women of Asian, White Hispanic, and Black Ethnicities had an increased risk of preterm birth compared to White Non-Hispanic mothers. Being of Native American ethnicity conferred a statistically significant protective effect on risk for preterm birth. Women of all other ethnicities did not differ significantly as compared to White Non-Hispanics (See Figure 3).

Figure 3. Adjusted odds ratio of preterm birth based on maternal ethnicity, reference ethnicity = White Non-Hispanic



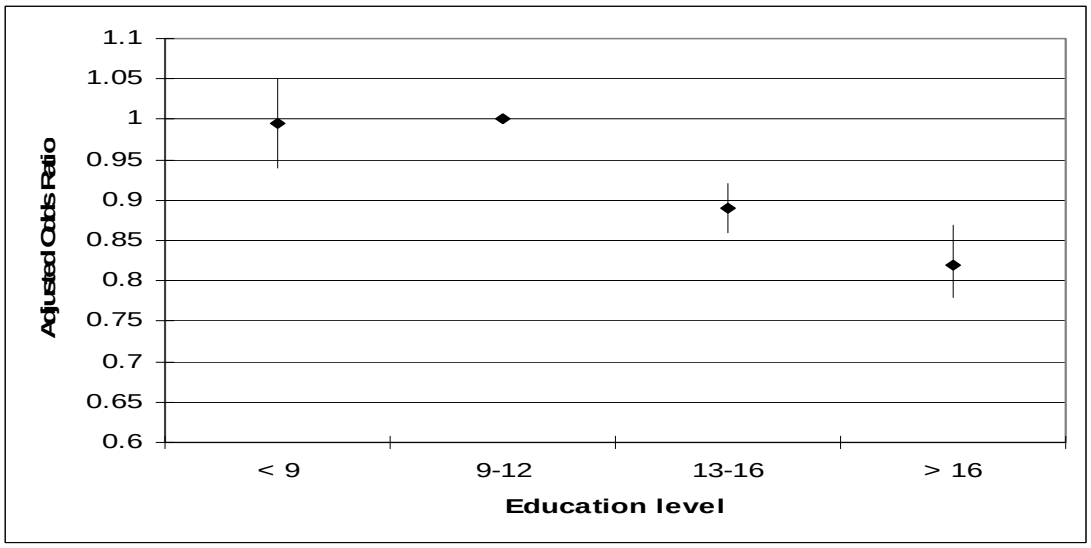
When maternal age was considered the comparison group, maternal age of 25-29, conferred the lowest risk of preterm birth, with risk increasing significantly on either side of the maternal age extremes. Age of less than 15 years of age seems to have the greatest predictive significance for preterm birth, with an odds ratio almost double that of mothers giving birth at ages 25-29 (See Figure 4).

Figure 4. Adjusted odds ratio of Preterm Birth based on maternal age. Reference age = 25-29



Having greater than 12 years of education has a statistically significant protective factor for preterm birth. Less than 9 years of education as compared to 9-12 years did not confer any statistically significant benefit or risk of preterm birth (Figure 5). We were interested in whether education levels had differing benefits across ethnicities. However, we found that the benefits of education in reducing PTB were consistently seen regardless of the ethnic group evaluated (data not shown).

Figure 5. Adjusted odds ratio of preterm birth based on maternal education level, reference education level = 9-12 years



Non-married mothers had an increased risk of preterm birth (OR= 1.14; 95% CI= 1.10-1.17; p <0.0001) as compared to women who were married at the time of parturition. Additionally, alcohol and tobacco use during pregnancy both increased the risk of preterm birth significantly, with an odds ratio of 1.37 (95% CI= 1.32-1.42; p <0.0001) for tobacco use in pregnancy and an odds ratio of 1.30 (95% CI=1.21-1.41; p <0.0001) for alcohol use.

Counties with rising adjusted PTB rates from 1991-2005 were Chaves, Dona Ana, Grant, Hidalgo, Lea, Lincoln, McKinley, Mora, Otero, Rio Arriba, San Juan and San Miguel. Counties with decreasing PTB rates were Sandoval and Santa Fe counties (see Appendix Table 6). All other counties did not have statistically significant trends (data not shown).

Discussion

In this analysis of births in New Mexico from 1991-2005, many risk factors for preterm birth were elucidated. We found that even with excluding fetal conditions that could predispose to preterm birth, almost 8% of babies were born at an early gestational age. Additionally, the rate of preterm birth is rising in New Mexico over 1991-2005 in a statistically significant way. This is consistent with the trends being seen around the country.[5-8] Those factors that seemed to confer greater risk were having too little or intensive amounts of prenatal care, those with high risk pregnancies, being of Asian, White Hispanic or Black ethnicities, extremes of age, less maternal education, non-married mothers, and alcohol or tobacco use. Protective factors in our analysis were having intermediate or adequate levels of prenatal care having no medical risk factors, being of Native American ethnicity, age 25-29, having more than a high school education, being married, and abstaining from alcohol and tobacco during pregnancy.

Women with missing, inadequate or intensive prenatal care per the Kotelchuck index had significantly increased odds of having a preterm birth. Intensive care indicates that the women needed to be monitored more thoroughly in their pregnancy for some reason due to a problem, which explains why this level of care correlates with an increased incidence of preterm birth. Women with inadequate or no prenatal care probably did not get the kind of monitoring they needed, especially if they had a high risk pregnancy and did not realize it. Unsurprisingly, having a high risk pregnancy increased the risk of preterm birth. However, among women with high risk pregnancies, having an intensive level of care decreases risk for preterm birth. This is encouraging because it means that providers who care for high risk pregnant patients can help modify their risk for preterm birth by intensive care and monitoring of their condition.

Black, Asian, and White Hispanics had an increased rate of preterm birth compared with White non-Hispanics. However, Native Americans actually had a decreased risk of preterm birth. The increased risk for preterm birth among black women is not surprising since we have many studies that have concentrated on the difference between Black and White women and PTB and have revealed an increased risk for Black women.[14-17] White Hispanics did have a statistically significant increase in risk for preterm birth but it was very slight, with an OR of only 1.05. Asians also had an

increased risk of preterm birth but not as great as Black women. More interesting, perhaps, is the protective effect of Native American ethnicity on preterm birth. There have not been many comparative studies on preterm birth in the Native American population, and despite the fact that the rate of PTB is rising in this population in the United States there appears to be a decreased risk for PTB. Perhaps beneficial further study would be to compare the rates of preterm birth between the various Native American tribes to see which tribe has the lowest risk of preterm birth. Interestingly, the Native American populations in New Mexico tend to be of low socioeconomic status. These data, in addition to the data that showed a non-statistically significant interaction between ethnicity and maternal education level, suggest that there are underlying genetic protective factors against PTB that are independent from socioeconomic status.

The age 25-29 seemed to be the nadir of risk from preterm birth in New Mexico. Our data showed an almost two fold increase in risk if the mother is younger than 15 and an odds ratio of 1.3 if the mother is over age forty. These data seem to concur with previous research that has shown a positive correlation between younger mothers and preterm birth.[10] Also, since previous articles have had conflicting results with regards to the association between PTB and advanced maternal age, it also adds data to show that in New Mexico being of older maternal age does increase risk as well.

Lower maternal education level and unmarried status, both surrogates of maternal socioeconomic status, demonstrated positive correlation with preterm birth. Having a high school equation or less conferred the greatest risk, while increasing education levels after high school modified risk, down to an odds ratio of 0.89 for college educated women and an odds ratio of 0.82 for women with some graduate level education. Additionally, being unmarried conferred a slight increase in risk with an odds ratio of 1.14. Although younger mothers who are predisposed to PTB are also more likely to have less education or be unmarried, these data were adjusted for those variables and so these risks are independent of other factors. These data demonstrate that in New Mexico, a poor state, women of lower socioeconomic status have increased risk for preterm birth, which also concurs with several other studies.[12-16]

Not surprisingly, substance use such as alcohol and tobacco use increased risk for preterm birth, as has also been demonstrated in several studies. The mechanisms

suggested included vasoconstriction and uteroplacental insufficiency in those mothers that use tobacco products, while the mechanism with PTB and maternal alcohol use is less clear.[10]

Santa Fe and Sandoval counties, the counties with decreasing rates of preterm birth are conjoining counties in the middle northern part of the state. The counties with increasing rates of preterm birth are mostly concentrated in both the northernmost and the southernmost portions of the state. This may be due to lower incomes in these counties, or other socioeconomic factors that we were not able to account for since they were not in the data set.

We have identified many risk factors for preterm birth among New Mexico women. We have also demonstrated that increased pregnancy surveillance by obstetrics providers helps modify the risk for preterm birth among these high risk women. Therefore attempts should be made among New Mexico providers to identify women who are at higher risk for preterm birth, such as being of age extremes, those of lower socioeconomic status, those of White Hispanic, Asian, or Black ethnicities and those with underlying medical risk factors and these high risk pregnancies should be monitored closely. We have recognized that further investigation should be done to elucidate tribal differences in preterm rates among New Mexican Native Americans. Additionally, further studies could be done to define more completely the impact of socioeconomic status on preterm birth using more direct measurements. By further study and increased provider vigilance hopefully we can help curb this significant health problem.

Appendix

Table 1. Adjusted odds ratio of Preterm Birth based on maternal age, reference age = 25-29

Age Group	Adjusted Odds Ratio	Confidence Interval	P value
<15	1.90	1.59-2.28	<0.0001
15-19	1.22	1.17-1.28	<0.0001
20-24	1.07	1.04-1.11	<0.0001
30-34	1.09	1.05-1.13	<0.0001
35-39	1.25	1.19-1.32	<0.0001
>40	1.34	1.23-1.47	<0.0001

Table 2 Adjusted odds ratio of preterm birth based on maternal education level, reference education level = 9-12 years

Education Level	Adjusted Odds Ratio	Confidence Interval	P value
<9	0.995	0.94-1.05	0.87
13-16	0.89	0.86-0.92	<0.0001
>16	0.82	0.78-0.87	<0.0001

Table 3. Adjusted odds ratio of preterm birth based on maternal ethnicity, reference ethnicity = White Non-Hispanic

Ethnicity	Adjusted Odds Ratio	Confidence Interval	P value
Asian	1.23	1.10-1.37	0.0002
Other	1.49	0.93-2.40	0.1003
White Hispanic	1.05	1.02-1.08	0.0032
Native American	0.88	0.83-0.93	<0.0001
Black	1.37	1.26-1.49	<0.0001

Table 4. Adjusted odds ratio of normal-risk pregnancy and level of prenatal care, reference= Kotelchuck adequate.

Kotelchuck index	Adjusted Odds Ratio	Confidence Interval	P value
None	4.92	4.64-5.21	<0.0001
Inadequate	2.16	2.06-2.26	<0.0001
Intermediate	0.93	0.87-0.98	0.0112
High	4.95	4.74-5.16	<0.0001

Table 5. Adjusted odds ratio of high-risk pregnancy and level of prenatal care, reference= Kotelchuck adequate.

Kotelchuck index	Adjusted Odds Ratio	Confidence Interval	P value
None	1.29	1.15-1.46	<0.0001
Inadequate	0.96	0.87-1.06	0.41
Intermediate	1.21	1.07-1.38	0.0025
High	0.74	0.68-0.80	<0.0001

Table 6. Counties with statistically significant increasing or decreasing rates of preterm birth, 1991-2005.

County	Odds Ratio	Confidence Interval	P value
Chaves	1.04	1.02-1.05	<0.0001
Dona Ana	1.02	1.01-1.03	0.001
Grant	1.06	1.04-1.08	<0.0001
Hidalgo	1.06	1.01-1.11	0.02
Lea	1.10	1.08-1.12	<0.0001
Lincoln	1.04	1.01-1.08	0.01
McKinley	1.02	1.01-1.04	0.0005
Mora	1.07	1.01-1.14	0.02
Otero	1.02	1.00-1.04	0.01
Rio Arriba	1.03	1.01-1.05	0.01
San Juan	1.02	1.01-1.04	0.0003
San Miguel	1.07	1.05-1.09	<0.0001
Sandoval	0.98	0.97-0.99	0.04
Santa Fe	0.96	0.95-0.97	<0.0001

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