Final Report #111

National Trends in the Perinatal and Infant Health of Rural American Indians (AIs) and Alaska Natives (ANs): Have the Disparities Between AI/ANs and Whites Narrowed?

June 2008

by

Laura-Mae Baldwin, MD, MPH
David C. Grossman, MD, MPH
Elise Murowchick, PhD
Eric H. Larson, PhD
Walter B. Hollow, MD
Jonathan R. Sugarman, MD, MPH
William L. Freeman, MD, MPH
L. Gary Hart, PhD

This University of Washington Rural Health Research Center study was funded by the federal Office of Rural Health Policy, Health Resources and Services Administration, Department of Health and Human Services.

WWAMI RURAL HEALTH RESEARCH CENTER

RHRC Rural Health Research & Policy Centers
Funded by the Federal Office of Rural Health Policy
www.ruralhealthresearch.org

ABOUT THE CENTER

The WWAMI Rural Health Research Center (RHRC) is one of eight centers supported by the Federal Office of Rural Health Policy (FORHP), a component of the Health Resources and Services Administration (HRSA) of the Public Health Service. The major focus of the WWAMI RHRC is to perform policy-oriented research on issues related to rural health care and the rural health professional workforce. Specific interests of the Center include the training and supply of rural health care providers and the content and outcomes of the care they provide; the availability and quality of care for rural women and children, including obstetric and perinatal care; and access to high-quality care for vulnerable and minority rural populations.

The WWAMI Rural Health Research Center is based in the Department of Family Medicine at the University of Washington School of Medicine, and has close working relationships with the WWAMI Center for Health Workforce Studies, state offices of rural health, and the other health science schools at the University, as well as with other major universities in the five WWAMI states: Washington, Wyoming, Alaska, Montana, and Idaho. The University of Washington has over 30 years of experience as part of a decentralized educational research and service consortium involving the WWAMI states, and the activities of the Rural Health Research Center are particularly focused on the needs and challenges in these states. The WWAMI RHRC also works closely with the associated Area Health Education Centers.

The Rural Health Working Paper Series is a means of distributing prepublication articles and other working papers to colleagues in the field. Your comments on these papers are welcome, and should be addressed directly to the authors. Questions about the WWAMI Rural Health Research Center should be addressed to:

Mark P. Doescher, MD, MSPH, Director
Susan M. Skillman, MS, Deputy Director
WWAMI Rural Health Research Center
Department of Family Medicine
School of Medicine
University of Washington
Box 354982
Seattle, WA 98195-4982
E-mail: rhrc@fammed.washington.edu
WWW: http://depts.washington.edu/uwrhrc/

The WWAMI Rural Health Research Center is supported by the Federal Office of Rural Health Policy, Health Resources and Services Administration, Public Health Service (grant #1U1CRH03712-02; $500,000, 100%).

ABOUT THE AUTHORS

LAURA-MAE BALDWIN, MD, MPH, is Professor and Director, Research Section, Department of Family Medicine, University of Washington School of Medicine.

DAVID C. GROSSMAN, MD, MPH, is Director of Preventive Care at Group Health Cooperative, Senior Investigator at the Group Health Center for Health Studies, and a Professor in the Department of Health Services, University of Washington School of Public Health and Community Medicine.

ELISE MUROWCHICK, PhD, was a Research Consultant in the Department of Family Medicine, University of Washington School of Medicine, at the time of this study.

ERIC H. LARSON, PhD, was a Senior Investigator at the WWAMI Rural Health Research Center at the time of this study and is currently a Senior Research Scientist at MEDEX Northwest, University of Washington School of Medicine.

WALTER B. HOLLOW, MD, MS, is a Clinical Associate Professor in the Department of Family Medicine, University of Washington School of Medicine.

JONATHAN R. SUGARMAN, MD, MPH, is President and CEO of Qualis Health and a Clinical Professor in the Department of Family Medicine, University of Washington School of Medicine.

WILLIAM L. FREEMAN, MD, MPH, was Director of the Indian Health Service Research Program at the time of this study and is currently Director of Tribal Community Health Programs, Northwest Indian College, Lummi Nation, Bellingham, Washington.

L. GARY HART, PhD, was Director of the WWAMI Rural Health Research Center and Professor in the Department of Family Medicine, University of Washington School of Medicine, at the time of this study and is currently Director of the Rural Health Office, University of Arizona Mel and Enid Zuckerman College of Public Health.

National Trends in the Perinatal and Infant Health of Rural American Indians (AIs) and Alaska Natives (ANs): Have the Disparities Between AI/ANs and Whites Narrowed?

LAURA-MAE BALDWIN, MD, MPH
DAVID C. GROSSMAN, MD, MPH
ELISE MUROWCHICK, PhD
ERIC H. LARSON, PhD
WALTER B. HOLLOW, MD
JONATHAN R. SUGARMAN, MD, MPH
WILLIAM L. FREEMAN, MD, MPH
L. GARY HART, PhD

ABSTRACT

OBJECTIVES

This study examines whether disparities in perinatal care and birth outcomes between rural American Indians and Alaska Natives (AI/ANs) and whites diminished during a period of policy and funding changes in maternal/child health.

METHODS

Using National Linked Birth and Infant Death Databases between 1985 and 1997, we compared prenatal care receipt, birthweight, infant death rates, and cause of death between 217,064 rural AI/AN and 5,032,533 rural non-Hispanic white singleton births.

RESULTS

Unadjusted rates of inadequate prenatal care among rural AI/ANs (1985-1987 36.3%; 1995-1997 26.3%) and postneonatal death (1985-1987 7.1/1,000; 1995-1997 4.8/1,000) improved significantly. Disparities between AI/ANs and whites in adjusted odds of postneonatal death (1985-1987 1.55 [1.41-1.71]; 1995-1997 1.46 [1.31-1.64]) and adjusted risk of inadequate prenatal care (1985-1987 1.67 [1.65-1.69]; 1995-1997 1.84 [1.81-1.87]) persisted. As recently as 1995-1997, there were over three times as many postneonatal infectious disease deaths among rural AI/ANs compared with rural whites and nearly twice as many postneonatal SIDS deaths and deaths due to unintentional injuries/accidents.

CONCLUSIONS

Significant improvements in rural AI/AN prenatal care use and postneonatal death rates are encouraging, but additional measures are needed to close persistent AI/AN-white gaps.

INTRODUCTION

Previous studies and reports published by the Indian Health Service have demonstrated dramatic improvements in perinatal health among American Indians and Alaska Natives (AI/ANs) over the past 50 years. Infant mortality rates declined substantially from 62.7/1,000 live births in 1955 to 9.3/1,000 live births in the years 1994-1996.[1] Yet disparities between AI/ANs and whites have persisted. In 1989-1991, AI/ANs overall had 2.4 times the rate of postneonatal death compared with the white population;[1] rural AI/ANs' postneonatal death rate was 2.6 times that of whites.[2]

Considerable attention has been paid since the mid-1980s to improving access to health care services and changing risk behaviors among pregnant women and infants, as well as modifying provider practices, with the intention of improving birth outcomes and lowering infant mortality rates.[3-5] Among the general population, some of these efforts have been associated with higher rates of early and adequate prenatal care, as well as declining postneonatal mortality rates, especially from sudden infant death syndrome (SIDS).[6-8] How these efforts have influenced the perinatal health status of AI/ANs specifically is unknown, however, especially among rural AI/ANs, many of whom live in remote rural settings that may be more distant from health services. Did the disparities in perinatal care and birth outcomes among rural AI/ANs and rural whites diminish, remain stable, or increase during a period of policy,

funding, and practice changes in maternal and child health care?

This study addresses these questions by examining trends in prenatal care receipt, low-birthweight rates, neonatal and postneonatal death rates, and causes of death among rural AI/ANs and whites between 1985 and 1997.

METHODS

STUDY DATABASE

This study is based on the 1985-1987, 1989-1991, and 1995-1997 National Linked Birth and Infant Death Data. The 1995-1997 database was the latest available from the National Center for Health Statistics (NCHS) at the time this study began. These databases contain selected information compiled from birth certificates for all 50 states and the District of Columbia on all live births during these three time periods. We obtained identifiers for the mother's county of residence for each birth in the database, allowing classification of counties as rural or urban. Death certificate data were linked to these births if the infant died within a year of birth.

STUDY POPULATION

The study population included singleton AI/AN and non-Hispanic white births to women who were U.S. residents in rural counties during the three study time periods. AI/AN births were those for which either the mother or father was reported as an American Indian or Alaska Native on the birth certificate. This differs from the NCHS practice since 1989 of tabulating births primarily by the race of the mother.[9] We included births with AI/AN fathers regardless of the mothers' racial identity because non-AI/AN women giving birth to children with AI/AN fathers are likely to be eligible for IHS services. Non-Hispanic white births were identified by the race and ethnicity of the mother only, after excluding those with AI/AN fathers. In the 1985-1987 time period, 27 states did not record Hispanic ethnicity. Because these states had low rates of births to Hispanic mothers**,** all white births were included in the non-Hispanic white comparison group. We chose white births for comparison because this group has consistently demonstrated attainable and more favorable perinatal health outcomes than AI/ANs.

STUDY VARIABLES

Outcome Variables: We created two measures of access to prenatal care: initiation of care in the first trimester, and receipt of an inadequate pattern of prenatal care based on the Adequacy of Prenatal Care Utilization Index developed by Milton Kotelchuck.[10]

Low birthweight was defined as under 2,500 grams. We identified all infant deaths within one year of birth and categorized these into neonatal deaths (less than 28 days of age) and postneonatal deaths (28 days of age through one year of age). Death rates are presented per 1,000 live births.

Cause of death is presented for the neonatal and postneonatal periods separately using both individual and aggregated International Classification of Diseases-9th Revision-based categories defined by the National Center for Health Statistics.[11,12]

Independent Variable: AI/AN or white race is the independent variable of interest. We created three AI/AN race categories for some subanalyses: both parents AI/AN, AI/AN mother only, AI/AN father only.

Maternal Characteristics: Rural births were those to mothers whose residence county on the birth certificate was classified as nonmetropolitan using the 1993 federal Office of Management and Budget's definition.[13] We applied the 1993 Office of Management and Budget's definition to all of the study births to maintain a consistent rural definition across the study periods. Each rural county was further categorized as remote rural or nonremote rural. Designation as remote rural required that the county was not adjacent to a metropolitan county and did not have a town with a population of 10,000 or more.

We described the following maternal characteristics for the births in all three time periods: age (< 18 years, 18-34 years, ≥ 35 years), educational attainment (< 12 years, 12 years, some college), marital status (married, unmarried), parity (0, 1-4, ≥ 5). Several other characteristics were available to describe the births in the 1989-1991 and the 1995-1997 cohorts: cigarette use (none, < 11 cigarettes per day, ≥ 11 cigarettes per day), alcohol use (none, 1-4 drinks per week, ≥ 5 drinks per week), pre-existing medical risk (one or more of the following: maternal cardiac disease, chronic hypertension, gestational or established diabetes), complications of labor (one or more of the following: eclampsia, anemia, oligohydramnios, incompetent cervix, uterine bleeding, abruptio placenta, placenta previa, pregnancy induced hypertension), and history of prior preterm birth or small for gestational age infant.

ANALYSES

We first compared maternal characteristics, receipt of prenatal care, low-birthweight rates, infant death rates, and cause of death between rural AI/AN and non-Hispanic white births nationally using chi-square tests. Unadjusted and adjusted odds ratios were calculated to compare differences between rural AI/ANs and non-Hispanic white births on all of these measures except cause of death**.** We calculated adjusted odds ratios using multiple logistic regression analysis, controlling for maternal characteristics available in all three time periods' data, including remote rural residence status. We repeated these regression analyses in 1989-1991 and 1995-1997 controlling for the expanded number

of variables (e.g., smoking, pregnancy complications), found comparable results, and have reported only the original regression results for all three time periods. Odds ratios were converted to relative risks for those outcomes occurring in over 10 percent of the population (inadequate prenatal care, first trimester care) using published methods.[14] We compared causes of death between rural AI/ANs and non-Hispanic whites using rate ratios, and tested for differences between these groups with chi-square tests.

RESULTS

There were 217,064 rural AI/AN and 5,032,533 rural non-Hispanic white singleton births during the three study time periods—roughly 70,000 AI/AN births and 1.6 million non-Hispanic white births in each. Compared with mothers of white infants, mothers of AI/AN infants were more likely to be under 18, to have completed less than 12 years of education, to be unmarried, to be multiparous, and to live a remote rural county (Table 1). Over the study period, there was a decreasing proportion of births to families with both an AI/AN father and mother. There was a small increase in the proportion of both AI/AN and white births that were to women 35 years and older. There was also a small increase in the proportion of births to teens

Table 1: Sociodemographic and Risk Characteristics of Singleton Rural AI/AN and Non-Hispanic White Births, 1985-1987, 1989-1991, 1995-1997†‡

Characteristic	1985-1987		1989-1991		1995-1997	
	AI/AN (n = 70,012)	White (n = 1,796,428)	AI/AN (n = 75,752)	White (n = 1,633,309)	AI/AN (n = 71,300)	White (n = 1,552,199)
Race of parents, %						
Both parents AI/AN	43.7	NA	41.3	NA	37.3	NA
AI/AN mother only	42.8	NA	44.2	NA	44.4	NA
AI/AN father only	13.5	NA	14.5	NA	18.2	NA
Mother's age, %						
< 18 years	7.7***	4.4	7.3***	4.5	8.5***	4.9
18-34 years	86.4	90.2	85.9	88.8	83.6	86.3
≥ 35 years	5.9	5.4	6.8	6.7	7.9	8.8
Mother's education, %§						
< 12 years of school	37.9***	20.2	35.7***	20.7	31.8***	18.6
12 years of school	43.3	45.9	44.2	44.9	43.1	39.9
≥ 1 year of college	18.8	33.9	20.2	34.4	25.0	41.4
Married, %	54.0***	86.5	49.0***	81.6	43.8***	75.4
Parity, %§						
0	32.3***	40.5	30.9***	40.7	35.9***	42.0
1-4	62.3	58.2	63.3	57.9	58.9	56.6
≥ 5	5.4	1.3	5.8	1.4	5.2	1.5
Remote, %	45.8***	26.7	44.7***	25.2	41.8***	24.7
Smoking, %§						
Nonsmoker	—	—	79.5***	77.7	79.2***	79.7
1-10 cigarettes/day	—	—	14.6	11.7	15.7	12.4
≥ 11 cigarettes/day	—	—	5.9	10.6	5.2	7.9
Drinking, %§						
Nondrinker	—	—	95.8***	98.3	97.9***	99.2
1-4 drinks/week	—	—	3.3	1.6	1.6	0.7
≥ 5 drinks/week	—	—	0.9	0.2	0.5	0.1
% with preexisting medical condition§||	—	—	5.1***	3.1	5.7***	3.7
% with complications of pregnancy§¶	—	—	13.2***	8.5	13.6***	9.6
% with prior preterm or small for gestational age infant§	—	—	2.3***	1.7	1.8***	1.6

NA = not applicable; — = no data available.
† Asterisks indicate statistically significant differences in overall chi-square tests between AI/AN and white populations within each time period: ***$P \leq 0.001$. Within the AI/AN population, all but one of the variables—proportion with complications of pregnancy—demonstrate statistically significant differences over time. Within the white population, all of the variables demonstrate statistically significant differences over time.
‡ Column percentages may not total 100% because of rounding error.
§ Missing values: 1985-1987: mother's education: AI/AN 7.1%, White 8.4%; parity: AI/AN 0.2%, White 0.3%. 1989-1991: mother's education: AI/AN 4.3%, White 5.0%; parity: AI/AN 0.2%, White 0.2%; smoking: AI/AN 22.0%, White 14.5%; drinking: AI/AN 22.1%, White 10.2%; preexisting medical conditions: AI/AN 10.2%, White 3.1%; complications of pregnancy: AI/AN 11.3%, White 9.8%; prior preterm infant: AI/AN 10.7%, White 6.5%. 1995-1997: mother's education: AI/AN 1.3%, White 0.6%, parity: AI/AN 0.3%, White 0.2%; smoking: AI/AN 13.3%, White 10.9%; drinking: AI/AN 12.6%, White 4.2%; preexisting medical conditions: AI/AN 2.1%, White 1.2%; complications of pregnancy: AI/AN 3.2%, White 5.2%; prior preterm infant: AI/AN 2.1%, White 1.2%.
|| Maternal cardiac disease, chronic hypertension, diabetes.
¶ Complications include eclampsia, anemia, oligohydramnios, incompetent cervix, uterine bleeding, abruptio placenta, placenta previa, pregnancy-induced hypertension.

under 18 years old, more so for AI/ANs. A decreasing proportion of births to both AI/ANs and whites was to unmarried mothers. A decreasing proportion of births to both AI/ANs and whites was to mothers living in remote rural counties.

Maternal risk factor data were available only in the second and third time periods. Compared with mothers of white infants, mothers of AI/AN infants were slightly more likely to smoke, but smoked fewer cigarettes per day. Mothers of AI/AN infants were more likely to drink alcohol, and to have had pre-existing medical conditions, labor complications, and a history of preterm births than mothers of white infants. Over the study period, there was a small decrease in the smoking rate for whites, and in the number of cigarettes smoked for AI/ANs. Both AI/ANs and whites decreased their drinking rates. There were increases in the proportion of both AI/ANs and whites with pre-existing medical conditions. Whites had an increase in their labor complication rates over the two time periods. AI/ANs demonstrated a meaningful and significant decrease in rates of prior premature or small for gestational age delivery.

Over the study period, prenatal care use increased substantially for both AI/ANs and whites (Figure 1, Table 2). The greatest improvement in prenatal care use occurred between the 1989-1991 and 1995-1997 time periods, during which time the disparity in the crude rates of inadequate prenatal care and first trimester prenatal care initiation narrowed between AI/ANs and whites. The adjusted risk of inadequate prenatal care for AI/ANs compared with whites increased over the study period, however (RR 1.67 to 1.84, Table 2). Further investigation demonstrated that this widening of the adjusted risk of inadequate prenatal care related to differing trends in inadequate prenatal care among single and married AI/ANs and whites. Among single women, the risk of inadequate prenatal care widened between AI/ANs and whites; among married women the inadequate prenatal care risk narrowed. Because AI/ANs are more likely to be single compared with whites in the later time period, the disparity in adjusted rates of inadequate prenatal care between AI/ANs and whites widened over time. The adjusted risk of first trimester prenatal care initiation for AI/ANs compared with whites did not change throughout the study period (RR 0.89 in both 1985-1987 and 1995-1997).

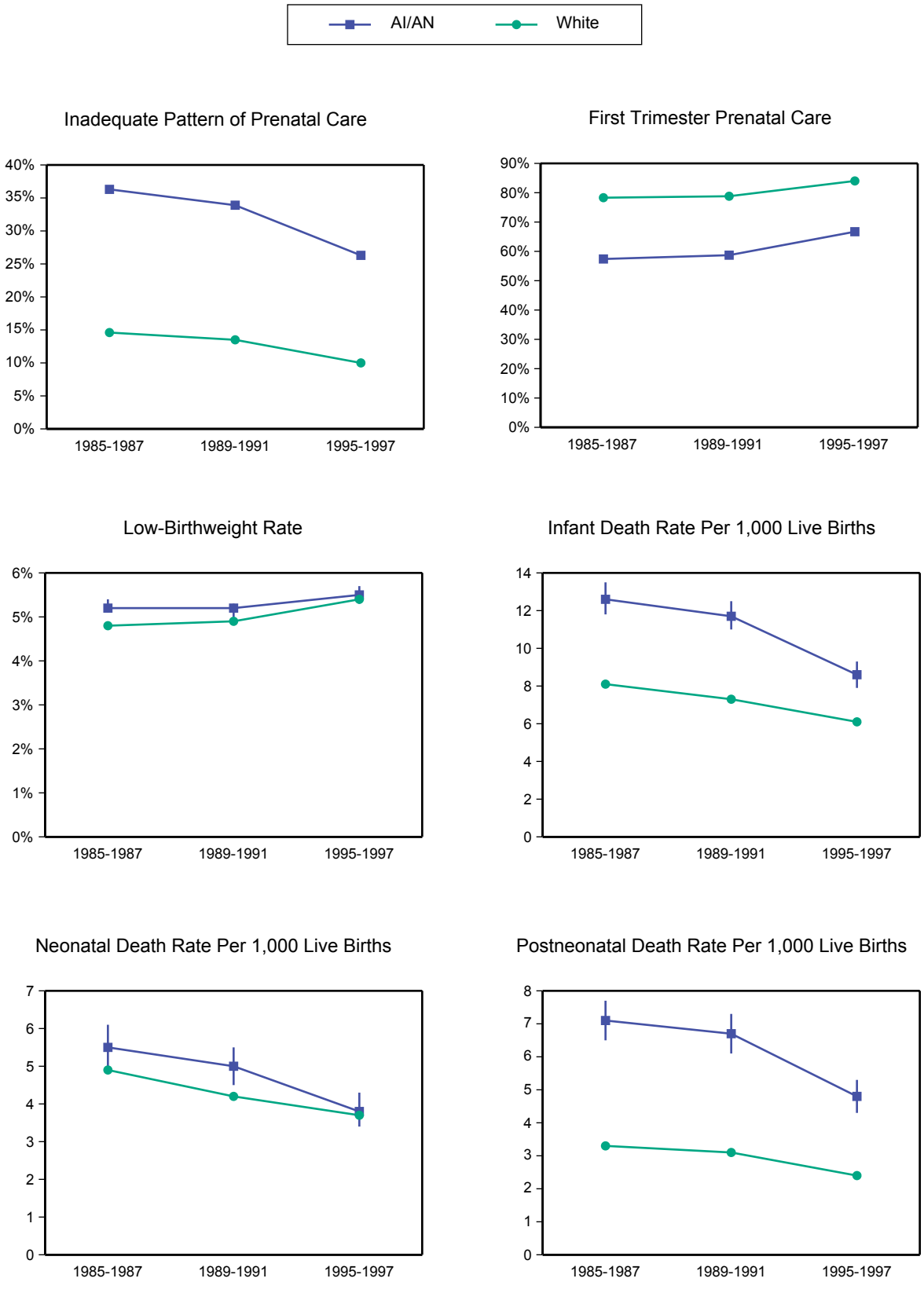
Low birthweight rates remained stable for AI/ANs throughout the study period, but increased slightly for whites in the 1995-1997 time period. The adjusted odds of having a low-birthweight infant was lower for AI/ANs compared with whites throughout the study period.

Neonatal, postneonatal, and overall infant death rates decreased for both AI/ANs and whites over the study period. The unadjusted neonatal death rate of AI/AN infants was higher than that of white infants in 1985-1987 and 1989-1991, but not in 1995-1997. After adjustment, the odds of an AI/AN infant dying in the neonatal period were no different from that of a white infant in the 1985-1987 and 1989-1991 time periods, and were lower than whites in the 1995-1997 time period. The postneonatal death rates of AI/AN infants were significantly higher than those of white infants in each of the three time periods, although the adjusted odds of postneonatal death among AI/AN infants compared with white infants did diminish slightly, but not statistically significantly, over time from 1.55 in 1985-1987 to 1.46 in 1995-1997.

Neonatal and postneonatal cause of death for AI/ANs and whites over the study period are presented in Table 3. In the neonatal period, congenital anomalies, respiratory conditions, and short gestation/low birthweight were the most common causes of death for AI/ANs and whites in all three time periods. While not a common cause of death in the neonatal period, AI/AN infants were more likely to have SIDS reported as the cause of death in the first 28 days of life than white infants in each of the three time periods (AI/AN to white rate ratios 1.97 in 1985-1987, 1.67 in 1989-1991, 2.47 in 1995-1997).

The most common causes of death in the postneonatal period for both AI/ANs and whites were SIDS, congenital anomalies, infectious disease, and unintentional injuries/accidents. AI/AN infants had higher rates of postneonatal death from each of these conditions as well as from homicide compared with white infants throughout the study period, although it is encouraging to note that the rate of postneonatal death among AI/ANs compared with whites for each of these measures decreased between 1985-1987 and 1995-1997. For SIDS and congenital anomalies, the 1995-1997 AI/AN:white postneonatal death rate ratios were about 87 percent that of the 1985-1987 rate ratios. For unintentional injuries/accidents and homicide, the 1995-1997 AI/AN:white postneonatal death rate ratios were 71 percent and 55 percent that of the 1985-1987 rate ratios, respectively. Despite these improvements, as recently as 1995-1997 there were over three times as many infectious disease deaths in the postneonatal period among rural AI/ANs compared with rural whites (54 AI/AN deaths, but only 16 white deaths in an equivalently sized population of 71,300). Similarly, there were nearly twice as many postneonatal SIDS deaths (112 AI/AN, 58 white) and deaths due to unintentional injuries/accidents (29 AI/AN, 16 white) among rural AI/ANs compared with rural whites in an equivalently sized population of 71,300.

Figure 1: Trends Over Time in Unadjusted Perinatal Outcomes by Race†



† See Table 2 for exact percentages and confidence intervals (represented by vertical lines). A number of confidence intervals are too narrow to be visible on this figure.

Table 2: Prenatal Care Receipt and Birth Outcomes of Singleton Rural AI/AN and White Births, 1985-1987, 1989-1991, 1995-1997†

	1985-1987‡				1989-1991‡				1995-1997‡			
	AI/AN (95% CI)	White (95% CI)	AI/AN-to-White Unadjusted Odds Ratio§|| (95% CI)	AI/AN-to-White Adjusted Odds Ratio§||¶ (95% CI)	AI/AN (95% CI)	White (95% CI)	AI/AN-to-White Unadjusted Odds Ratio§|| (95% CI)	AI/AN-to-White Adjusted Odds Ratio§||¶ (95% CI)	AI/AN (95% CI)	White (95% CI)	AI/AN-to-White Unadjusted Odds Ratio§|| (95% CI)	AI/AN-to-White Adjusted Odds Ratio§||¶ (95% CI)
% who received inadequate pattern of prenatal care	36.29*** (35.92, 36.66)	14.62 (14.57, 14.67)	2.48 (2.46, 2.51)	1.67 (1.65, 1.69)	33.86*** (33.52, 34.20)	13.47 (13.42, 13.52)	2.51 (2.49, 2.54)	1.75 (1.73, 1.78)	26.32*** (25.99, 26.65)	9.96 (9.91, 10.01)	2.64 (2.61, 2.68)	1.84 (1.81, 1.87)
% with first-trimester care	57.36*** (56.99, 57.73)	78.29 (78.23, 78.35)	0.733 (0.728, 0.738)	0.89 (0.88, 0.89)	58.69*** (58.34, 59.04)	78.80 (78.74, 78.86)	0.745 (0.740, 0.749)	0.88 (0.88, 0.89)	66.70*** 66.35, 67.05)	84.01 (83.95, 84.07)	0.794 (0.790, 0.798)	0.89 (0.89, 0.90)
% low birthweight (< 2,500 grams)	5.21*** (5.05, 5.38)	4.79 (4.76, 4.82)	1.09 (1.06, 1.13)	0.89 (0.86, 0.92)	5.16*** (5.00, 5.32)	4.87 (4.84, 4.90)	1.06 (1.03, 1.10)	0.89 (0.86, 0.92)	5.50 (5.33, 5.67)	5.38 (5.34, 5.42)	1.02 (0.99, 1.06)	0.87 (0.85, 0.90)
Mortality (rate/1,000)												
Neonatal (0-28 days)	5.47* (4.92, 6.02)	4.88 (4.78, 4.98)	1.12 (1.01, 1.24)	0.93 (0.84, 1.03)	5.02*** (4.52, 5.52)	4.19 (4.09, 4.29)	1.20 (1.08, 1.33)	1.04 (0.93, 1.15)	3.80 (3.35, 4.25)	3.70 (3.60, 3.80)	1.03 (0.91, 1.16)	0.85 (0.75, 0.97)
Postneonatal (29 days to 1 year)	7.13*** (6.51, 7.75)	3.27 (3.19, 3.35)	2.19 (2.00, 2.40)	1.55 (1.41, 1.71)	6.69*** (6.11, 7.27)	3.15 (3.06, 3.24)	2.14 (1.95, 2.34)	1.50 (1.36, 1.65)	4.80*** (4.29, 5.31)	2.40 (2.32, 2.48)	2.01 (1.79, 2.24)	1.46 (1.31, 1.64)
Infant death (first year total)	12.60*** (11.77, 13.43)	8.14 (8.01, 8.27)	1.55 (1.45, 1.66)	1.20 (1.12, 1.29)	11.71*** (10.94, 12.48)	7.34 (7.21, 7.47)	1.60 (1.50, 1.72)	1.26 (1.18, 1.35)	8.60*** (7.92, 9.28)	6.10 (5.98, 6.22)	1.41 (1.30, 1.53)	1.11 (1.02, 1.21)
Number of births	70,012	1,796,428	NA	NA	75,752	1,633,309	NA	NA	71,300	1,552,199	NA	NA
	1,866,440				1,709,061				1,623,499			

CI = confidence interval; NA = not applicable.
† Asterisks indicate statistically significant differences between AI/AN and white populations within each time period: *$P \leq 0.05$, ***$P \leq 0.001$.
‡ Missing values: 1985-1987: inadequate pattern of prenatal care: AI/AN 7.7%, White 6.4%; first trimester care: AI/AN 2.5%, White 1.7%; low birthweight: AI/AN 0.2%, White 0.1%. 1989-1991: inadequate pattern of prenatal care: AI/AN 3.5%, White 2.7%; first trimester care: AI/AN 1.9%, White 1.1%; low birthweight: AI/AN 0.2%, White 0.1%. 1995-1997: inadequate pattern of prenatal care: AI/AN 3.7%, White 2.7%; first trimester care: AI/AN 2.1%, White 1.2%; low birthweight: AI/AN 0.1%, White 0.03%.
§ Using published methods,[14] odds ratios converted to relative risks for inadequate pattern of prenatal care and first-trimester care variables because these outcomes are common in the study population.
|| Odds ratios were converted to relative risks for inadequate pattern of prenatal care and first trimester care variables using published methods.[14]
¶ Multiple logistic regression adjusted for mother's age, age^2, parity, education, marital status, residence in a remote rural area.

Table 3: Causes and Rates of Neonatal and Postneonatal Death Among AI/AN and White Births, 1985-1987, 1989-1991, 1995-1997†

	1985-1987			1989-1991			1995-1997		
	AI/AN Rate/1,000 Live Births	White Rate/1,000 Live Births	AI/AN-to-White Ratio	AI/AN Rate/1,000 Live Births	White Rate/1,000 Live Births	AI/AN-to-White Ratio	AI/AN Rate/1,000 Live Births	White Rate/1,000 Live Births	AI/AN-to-White Ratio
Neonatal Death									
1. Congenital anomalies	1.63	1.62	1.00	1.62	1.45	1.12	1.15	1.30	0.89
2. Respiratory distress syndrome	0.59	0.56	1.05	0.42	0.44	0.97	0.29	0.22	1.32
3. Other respiratory conditions	0.51	0.52	0.99	0.50	0.38	1.33	0.13	0.26	0.49*
4. Short gestation, unspecified low birthweight-related disorders	0.60	0.48	1.25	0.45	0.49	0.91	0.56	0.49	1.15
5. Complications of cord, membrane, placenta	0.17	0.21	0.81	0.24	0.19	1.25	0.36	0.18	1.99**
6. Intrauterine hypoxia, birth asphyxia	0.24	0.20	1.20	0.24	0.12	1.97**	0.10	0.12	0.81
7. Infections specific to perinatal period	0.23	0.20	1.17	0.21	0.17	1.21	0.11	0.14	0.80
8. Complications of pregnancy	0.23	0.15	1.57	0.22	0.16	1.39	0.11	0.20	0.57
9. Sudden infant death syndrome	0.19	0.09	1.97*	0.16	0.10	1.66	0.15	0.06	2.52**
10. Infectious diseases	0.04	0.04	1.00	0.15	0.05	3.15***	0.06	0.05	1.02
11. Maternal conditions	0.03	0.03	1.05	0.03	0.03	0.84	0.08	0.02	3.44*
12. Unintentional injuries/accidents	0.04	0.02	2.33	0.07	0.02	2.87*	0.01	0.02	0.70
13. Homicide	0.01	0.004	3.21	—	0.01	—	—	0.01	—
14. All other causes	0.96	0.75	1.27	0.71	0.59	1.22	0.67	0.62	1.09
Postneonatal Death									
1. Sudden infant death syndrome	2.81	1.27	2.22***	2.73	1.31	2.09***	1.57	0.80	1.95***
2. Congenital anomalies	0.76	0.51	1.50**	0.82	0.52	1.59***	0.56	0.43	1.30
3. Infectious disease	1.17	0.35	3.40***	0.94	0.27	3.44***	0.76	0.23	3.35***
4. Unintentional injuries/accidents	0.60	0.24	2.46***	0.70	0.24	2.87***	0.41	0.23	1.80**
5. Other respiratory conditions	0.11	0.10	1.14	0.05	0.08	0.70	0.06	0.05	1.09
6. Respiratory distress syndrome	0.07	0.04	1.83	0.07	0.04	1.83	—	0.02	—
7. Homicide	0.14	0.03	4.58***	0.12	0.04	2.83**	0.14	0.05	2.26**
8. Intrauterine hypoxia, birth asphyxia	—	0.01	—	—	0.01	—	—	0.01	—
9. Infections specific to the perinatal period	0.01	0.01	1.83	—	0.01	—	0.01	0.01	1.67
10. Short gestation, unspecified low-birthweight disorders	—	0.01	—	—	0.01	—	0.01	0.01	2.18
11. Complications of cord, membrane, placenta	—	0.001	—	—	0.003	—	—	0.003	—
12. Complications of pregnancy	—	0.001	—	—	—	—	—	0.001	—
13. Maternal conditions	0.01	—	—	0.03	0.001	26.0**	0.01	0.001	21.77
14. All other causes	1.43	0.71	2.03***	1.24	0.62	1.99***	1.26	0.56	2.26***

— = no deaths from this cause in this study time period.

† Asterisks indicate statistically significant differences in death rates/1,000 live births between AI/AN and white populations within each time period: *$P \leq 0.05$, **$P \leq 0.01$, ***$P \leq 0.001$.

DISCUSSION

This study examines the perinatal outcomes among rural AI/ANs and whites during a time period in which funding for public programs in maternal and child health expanded, but the U.S. Commission on Civil Rights, Noren et al., and Roubideaux document that funding for the Indian Health Service fell far below what was necessary to provide for the health care needs of AI/ANs.[15-17] Paying particular attention to rural AI/ANs is important because of the very high proportion of AI/ANs living in rural settings—39.5 percent in the 2000 census—and the more limited medical resources available in rural areas.[18-20] The significant improvement in access to prenatal care and infant death rates among both rural AI/ANs and rural whites between the mid-1980s and the late 1990s is encouraging. The persistent disparities between rural AI/ANs and rural whites in access to care and infant death are of considerable concern, however.

The late 1980s and early 1990s was a time of expanded funding of programs both to enroll low income pregnant women into Medicaid as early as possible to ensure their receipt of timely prenatal care and to provide services such as case management and social support for women with high risk pregnancies.[3] Thus, it is not surprising that this study documents improvements among both rural AI/ANs and whites in use of early and adequate prenatal care, and that these improvements were most dramatic directly following the most intensive period of Medicaid expansions for maternity care. It is disappointing that the rural AI/AN population, whose very high rates of inadequate and late initiation of prenatal care afforded the opportunity for dramatic improvement, demonstrated deterioration compared with the white population in adequacy of prenatal care, as shown in our adjusted analyses. This is of particular concern since rural AI/ANs have persistently higher rates of preexisting medical conditions, such as cardiac disease, chronic hypertension, and diabetes, which may benefit from early and ongoing intervention in pregnancy. Of note, neither the rural AI/AN nor the rural white populations met the Healthy People 2000 goal of 90 percent of women receiving first trimester care, although rural AI/ANs continued to fall far below this target, with only 66.7 percent receiving first trimester care in the 1995-1997 time period.[21]

Our prior analyses of the 1989-1991 National Linked Birth and Infant Death Data had demonstrated the marked disparity in infant death rates between AI/ANs and whites, and identified the disparity to be among infants in the postneonatal period.[2] The current study demonstrates that both the neonatal and postneonatal death rates decreased continuously from 1985-1987 through 1995-1997, with the greatest decline occurring between 1989-1991 and 1995-1997. In these outcomes, rural AI/ANs made some gains relative to whites in postneonatal mortality. Nonetheless, even in 1995-1997, the odds of postneonatal death among rural AI/AN infants were still 1.46 times that of white infants. By the 1995-1997 time period, rural whites met the Healthy People 2000 objectives that the infant death rate fall below 7, the neonatal death rate below 4.5, and the postneonatal death rate below 2.5 per 1,000 live births. The Healthy People 2000 objectives for AI/AN infants were less ambitious, with target rates of 8.5 infant deaths, 4.5 neonatal deaths, and 4 postneonatal deaths per 1,000 live births. The rural AI/AN infants reached or came very close to each of these goals.

Our cause of death analysis suggests that the greatest gains in closing the postneonatal death rate disparity between rural AI/ANs and whites were in the areas of SIDS and congenital anomalies, the two most common causes of postneonatal death, as well as in the less common causes of unintentional injuries/accidents and homicide. The relatively common cause of death in which there was little improvement among rural AI/ANs relative to rural whites was infectious disease, most commonly pneumonia. This is consistent with recent literature demonstrating the substantial burden of lower respiratory tract disease among AI/ANs.[22,23] These infections are largely treatable and preventable, suggesting that significant improvement in rural AI/AN postneonatal mortality rates could occur with early care for infectious illnesses.

Low birthweight, a frequently used measure of perinatal health, is similar between AI/ANs and whites and is a finding reported elsewhere in the literature.[24] It is therefore not surprising that neonatal death rates, which are largely determined by birthweight, are comparable between the rural AI/ANs and the rural whites.

This study is limited by some inconsistency in the data between the three time periods, including lack of measurement of Hispanic ethnicity in 27 states during the 1985-1987 time period, which may have misclassified some individuals of Hispanic ethnicity as white. This would have minimized the differences between rural AI/AN and white populations in that time period, although we expect the impact to be small since most of the states with the largest Hispanic populations were gathering these data at that time. In addition, several of the maternal risk characteristics (e.g., cigarette use, complications of pregnancy) were not available in the 1985-1987 data. Thus, we were only able to control for a limited number of covariates in our regressions. However, we conducted a subanalysis limited to births in the 1989-1991 and 1995-1997 time periods, controlling for a full set of variables, and did not find meaningful differences in our results.

Another limitation of this study is the age of the data, which may not be representative of the current situation. These data were the most current available when this study was begun, however, and this analysis tracks

rural AI/AN and white perinatal care and birth outcomes during an important period of policy and funding changes in maternal and child health.

Our identification of mothers' residence location as rural was done at the level of the county. ZIP code-based rural classifications are more accurate, but ZIP code of mother's residence at birth is not available in the Linked Birth and Infant Death Data. Thus, these results do not reflect the outcomes of births in rural ZIP codes located in urban counties. Also, it is important to note that the data reported here reflect outcomes for women living in rural areas both within and outside IHS areas. However, the vast majority of the AI/AN births in this study, 83.0 percent, were to women living in IHS area counties, so that much of the care that these women received was in IHS-funded facilities.

This study reports encouraging news about significant improvements in perinatal health indicators among rural AIs and ANs between the 1980s and 1990s. The perinatal health of rural white populations improved alongside that of AI/ANs. As a result, disparities between AI/ANs and whites in postneonatal death rates and prenatal care access either remained stable or deteriorated somewhat. There have been a number of changes over the past few decades in the organization of health services for AI/ANs, with increased tribal autonomy over their health systems.[17,25] Tribal control over health services provides an excellent opportunity to improve perinatal and infant outcomes by implementing culturally appropriate interventions that could prevent or modify preexisting risk factors such as hypertension and diabetes know to be higher among AI/ANs,[26-29] increase prenatal care use, and decrease the risk of preventable conditions such as infection that result in postneonatal death. However, some groups, especially those from direct Indian Health Service and tribal health programs, face challenges due to the sizeable proportion of rural AI/ANs living in remote locations, where it is difficult to recruit both primary care and specialty physicians, and there are fewer health care facilities with more limited services, longer distances to health care providers, and lack of public transportation options.[30] Adequate funding is needed to ensure that AI/ANs have access to services and programs that help prevent postneonatal infant death and that AI/ANs continue to experience improvements in access to prenatal care.[31] In this way, AI/ANs will have an opportunity to reach the Healthy People 2010 objectives,[32] in which AI/ANs and whites are expected to reach the same goals.

REFERENCES

1. Indian Health Service. *Trends in Indian health 1998-99*. Washington, DC: U.S. Department of Health and Human Services; 1999.

2. Baldwin LM, Grossman DC, Casey S, et al. Perinatal and infant health among rural and urban American Indians/Alaska Natives. *Am J Public Health.* Sep 2002;92(9):1491-1497.

3. Gold RB, Singh S, Frost J. The Medicaid eligibility expansions for pregnant women: evaluating the strength of state implementation efforts. *Fam Plann Perspect.* Sep-Oct 1993;25(5):196-207.

4. American Academy of Pediatrics Committee on Infectious Diseases and Committee on Fetus and Newborn: guidelines for prevention of group B streptococcal (GBS) infection by chemoprophylaxis. *Pediatrics.* Nov 1992;90(5):775-778.

5. Willinger M, Hoffman HJ, Hartford RB. Infant sleep position and risk for sudden infant death syndrome: report of meeting held January 13 and 14, 1994, National Institutes of Health, Bethesda, MD. *Pediatrics.* May 1994;93(5):814-819.

6. Epstein AM, Newhouse JP. Impact of Medicaid expansion on early prenatal care and health outcomes. *Health Care Financ Rev.* 1998;19(4):85-99.

7. Malloy MH, Freeman DH. Age at death, season, and day of death as indicators of the effect of the back to sleep program on sudden infant death syndrome in the United States, 1992-1999. *Arch Pediatr Adolesc Med.* Apr 2004;158(4):359-365.

8. Howell EM. The impact of the Medicaid expansions for pregnant women: a synthesis of the evidence. *Med Care Res Rev.* Mar 2001;58(1):3-30.

9. Technical appendix from vital statistics of the United States, 1989. Volume I—natality. In: *Linked birth/infant death data set: 1989 birth cohort*. Hyattsville, MD: U.S. Department of Health and Human Services; 1995:5-6.

10. Kotelchuck M. An evaluation of the Kessner Adequacy of Prenatal Care Index and a proposed Adequacy of Prenatal Care Utilization Index. *Am J Public Health.* Sep 1994;84(9):1414-1420.

11. *International classification of diseases, 9th revision*. Geneva, Switzerland: World Health Organization; 1980.

12. Technical appendix from vital statistics of the United States, 1989. Volume II—mortality. In: *Linked birth/infant death data set: 1989 birth cohort*. Hyattsville, MD: U.S. Department of Health and Human Services; 1995:8-11.

13. Ghelfi LM, Parker TS. A county level measure of urban influence. *Rural Development Perspectives.* 1997;12(2):32-41.

14. Zhang J, Yu KF. What's the relative risk? A method of correcting the odds ratio in cohort studies of common outcomes. *JAMA.* Nov 18 1998;280(19):1690-1691.

15. U.S. Commission on Civil Rights. *A quiet crisis: federal funding and unmet needs in Indian country*. Washington, DC: Author; 2003.

16. Noren J, Kindig D, Sprenger A. Challenges to Native American health care. *Public Health Rep.* Jan-Feb 1998;113(1):22-33.

17. Roubideaux Y. Perspectives on American Indian health. *Am J Public Health.* Sep 2002;92(9):1401-1403.

18. U.S. Census Bureau. Census 2000 summary file 2 (SF2) 100-percent data. Available at: http://factfinder.census.gov. Accessed February 7, 2006.

19. Hart LG, Salsberg E, Phillips DM, Lishner DM. Rural health care providers in the United States. *J Rural Health.* 2002;18 Suppl:211-232.

20. Hassinger EW, Hicks LL, Godino V. A literature review of health issues of the rural elderly. *J Rural Health.* Winter 1993;9(1):68-75.

21. U.S. Department of Health and Human Services. *Healthy people 2000: national health promotion and disease prevention objectives*. Washington, DC: Public Health Service; 1991.

22. Holman RC, Curns AT, Cheek JE, Singleton RJ, Anderson LJ, Pinner RW. Infectious disease hospitalizations among American Indian and Alaska Native infants. *Pediatrics.* Feb 2003;111(2):E176-182.

23. Peck AJ, Holman RC, Curns AT, et al. Lower respiratory tract infections among American Indian and Alaska Native children and the general population of U.S. children. *Pediatr Infect Dis J.* Apr 2005;24(4):342-351.

24. U.S. Department of Health and Human Services. *National health care disparities report*. Rockville, MD: Agency for Healthcare Research and Quality; 2003.

25. Kunitz SJ. The history and politics of US health care policy for American Indians and Alaskan Natives. *Am J Public Health.* Oct 1996;86(10):1464-1473.

26. Howard BV, Lee ET, Cowan LD, et al. Rising tide of cardiovascular disease in American Indians. The Strong Heart Study. *Circulation.* May 11 1999;99(18):2389-2395.

27. Acton KJ, Burrows NR, Moore K, Querec L, Geiss LS, Engelgau MM. Trends in diabetes prevalence among American Indian and Alaska native children, adolescents, and young adults. *Am J Public Health.* Sep 2002;92(9):1485-1490.

28. Oser CS, Harwell TS, Strasheim C, et al. Increasing prevalence of cardiovascular risk factors among American Indians in Montana. *Am J Prev Med.* Apr 2005;28(3):295-297.

29. Denny CH, Holtzman D, Cobb N. Surveillance for health behaviors of American Indians and Alaska Natives. Findings from the Behavioral Risk Factor Surveillance System, 1997-2000. *MMWR Surveill Summ.* Aug 1 2003;52(7):1-13.

30. Ricketts TC. *Rural health in the United States.* New York: Oxford University Press; 1999.

31. Schneider A. Reforming American Indian/Alaska Native health care financing: the role of Medicaid. *Am J Public Health.* May 2005;95(5):766-768.

32. U.S. Department of Health and Human Services. *Healthy people 2010: understanding and improving health*. 2nd ed. Washington, DC: U.S. Government Printing Office; 2000.

RELATED RESOURCES FROM THE WWAMI RURAL HEALTH RESEARCH CENTER AND THE CENTER FOR HEALTH WORKFORCE STUDIES

WORKING PAPERS

Baldwin LM, Hollow WB, Casey S, et al. *Access to specialty health care for rural American Indians: provider perceptions in two states.* Working Paper #78. Seattle, WA: WWAMI Rural Health Research Center, University of Washington; 2004.

Benedetti TJ, Baldwin LM, Andrilla CHA, Hart LG. *The productivity of Washington State's obstetrician-gynecologist workforce: does gender make a difference?* Working Paper #82. Seattle, WA: WWAMI Center for Health Workforce Studies, University of Washington; 2003.

Nesbitt TS, Rosenblatt RA, Connell FA, Hart LG. *Access to obstetrical care in rural areas: effect on birth outcomes.* Working Paper #4. Seattle, WA: WWAMI Rural Health Research Center, University of Washington; 1989.

OTHER PUBLICATIONS

Baldwin LM, Grossman DC, Casey S, et al. Perinatal and infant health among rural and urban American Indians/Alaska Natives. *Am J Public Health.* Sep 2002;92(9):1491-1497.

Cullen TJ, Lishner DM, Hart LG, Rosenblatt RA. *Declining availability of obstetrical providers in rural America.* Deliverable report #2. Submitted to National Rural Health Association under contract with the Bureau of Health Professions as part of the Study of Health Professionals Distribution, Training and Service Models to Meet Rural Health Care Needs Study. Seattle, WA: WWAMI Rural Health Research Center, University of Washington; 1990.

Cullen TJ, Lishner DM, Hart LG, Rosenblatt RA. Chapter VI: obstetrical providers. In: Health Resources and Services Administration, ed. *Study of models to meet rural health care needs through mobilization of health professions education and services utilization.* Funded by a Bureau of Health Professions contract with the National Rural Health Association. Kansas City, MO: National Rural Health Association; 1992:143-189.

Cullen TJ, Lishner DM, Rosenblatt RA. *Declining availability of obstetrical providers in rural America: analysis of recent literature.* Deliverable Report #1. Submitted to National Rural Health Association under contract with the Bureau of Health Professions as part of the Study of Health Professionals Distribution, Training, and Service Models to Meet Rural Health Care Needs Study. Seattle, WA: WWAMI Rural Health Research Center, University of Washington; 1990.

Dobie S, Hart LG, Fordyce M, Andrilla CH, Rosenblatt RA. Obstetric care and payment source: do low-risk Medicaid women get less care? *Am J Public Health.* Jan 1998;88(1):51-56.

Hart LG, Dobie SA, Baldwin LM, Pirani MJ, Fordyce M, Rosenblatt RA. Rural and urban differences in physician resource use for low-risk obstetrics. *Health Serv Res.* Oct 1996;31(4):429-452.

Larson EH, Hart LG, Rosenblatt RA. Is non-metropolitan residence a risk factor for poor birth outcome in the U.S.? *Soc Sci Med.* Jul 1997;45(2):171-188.

Larson EH, Hart LG, Rosenblatt RA. Rural residence and poor birth outcome in Washington State. *J Rural Health.* Summer 1992;8(3):162-170.

Lishner DM, Rosenblatt RA, Cullen TJ, Hart LG. *Creation of integrated rural health care delivery systems to facilitate local availability of basic obstetrical care.* Deliverable Report #3, submitted to National Rural Health Association under contract with the Bureau of Health Professions as part of the Study of Health Professionals Distribution, Training and Service Models to Meet Rural Health Care Needs Study. Seattle, WA: WWAMI Rural Health Research Center, University of Washington; 1990.

Nesbitt TS, Larson EH, Rosenblatt RA, Hart LG. Access to maternity care in rural Washington: its effect on neonatal outcomes and resource use. *Am J Public Health.* Jan 1997;87(1):85-90.

Rosenblatt RA, Dobie SA, Hart LG, et al. Interspecialty differences in the obstetric care of low-risk women. *Am J Public Health.* Mar 1997;87(3):344-351.

Rosenblatt RA, Saunders GR, Tressler CJ, Larson EH, Nesbitt TS, Hart LG. The diffusion of obstetric technology into rural U.S. hospitals. *Int J Technol Assess Health Care.* Summer 1994;10(3):479-489.

Rosenblatt RA, Whelan A, Hart LG. Obstetric practice patterns in Washington State after tort reform: has the access problem been solved? *Obstet Gynecol.* Dec 1990;76(6):1105-1110.

For a complete list of publications by the Rural Health Research Center, visit http://depts.washington.edu/uwrhrc/.

mar RWB:cj2008:m:b 6/25/08