Perinatal and Infant Health Among Rural and Urban American Indians/Alaska Natives

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Objectives. We sought to provide a national profile of rural and urban American Indian/Alaska Native (AI/AN) maternal and infant health.

Methods. In this cross-sectional study of all 1989–1991 singleton AI/AN births to US residents, we compared receipt of an inadequate pattern of prenatal care, low birthweight (<2500 g), infant mortality, and cause of death for US rural and urban AI/AN and non-AI/AN populations.

Results. Receipt of an inadequate pattern of prenatal care was significantly higher for rural than for urban mothers of AI/AN infants (18.1% vs 14.4%, $P \leq .001$); rates for both groups were over twice that for Whites (6.8%). AI/AN postneonatal death rates (rural=6.7 per 1000; urban=5.4 per 1000) were more than twice that of Whites (2.6 per 1000).

Conclusions. Preventable disparities between AI/ANs and Whites in maternal and infant health status persist. (*Am J Public Health.* 2002;92:1491–1497)

American Indians and Alaska Natives (AI/ANs) are known to have decreased life expectancy and disproportionately high rates of morbidity associated with a broad range of health problems.[1,2] Nonetheless, considerable gains have been realized since the Indian Health Service (IHS) was established as the lead health agency commissioned to improve AI/AN health status.[2] Some of the greatest gains have been made in the area of infant and child health. Since 1955, when the IHS was created, reported infant mortality rates among AI/ANs in IHS areas have dropped dramatically, from 62.7 per 1000 live births in 1955 to 8.7 per 1000 live births in 1993. The reported neonatal mortality rate in IHS areas in 1992 through 1994 was 4.1 per 1000 live births, compared with 5.3 per 1000 live births for the entire United States and 4.3 per 1000 live births for Whites.[2,3] The postneonatal mortality rate among AI/ANs (4.6 per 1000 live births) continues to lag behind that of Whites (2.5 per 1000 live births) but is approaching the overall US rate (3.1 per 1000 live births).

Despite these encouraging trends, little is known about how different subpopulations of the entire AI/AN population have fared. The IHS tracks health indicators only in those geographic areas where it has service obligations (all or part of 35 states).[2,4] Most of these areas are nonmetropolitan counties with tribal lands that have either IHS-administered or tribally run health programs. Approximately 56% of the AI/AN population lives in urban areas,[5] however, and many who live away from their home reservations have limited access to tribal health services.

In recognition of the increasing urban demographic shift, the US Congress authorized the Urban Indian Program under Title V of the 1976 Indian Health Improvement Act.[6] This legislation led to the establishment of urban health programs outside IHS service boundaries where substantial AI/AN populations lived. This program, accounting for less than 2% of the current IHS budget,[7] supports 34 individual urban programs outside IHS service areas, many of which provide referral information and health education only. In addition, some urban areas (e.g., Anchorage, Oklahoma City, Phoenix) have IHS or tribally run clinical programs that are supported by regular IHS hospital and clinic budgets.

The health status and trends within the urban AI/AN population are largely unknown. IHS statistical reports do not stratify health status reports by rural/urban location of residence, and AI/ANs not residing in defined service areas are not included in aggregate statistical reports. Although several studies have used selected data (e.g., from individual counties or metropolitan areas) to examine the maternal or infant health status of urban AI/ANs and differences between rural and urban AI/AN maternal and infant health status, none have used population-based data[8,9] to examine national urban maternal and infant health status. A full picture of rural and urban AI/AN maternal and infant health, both inside and outside the IHS system, is needed to assess unmet needs and progress toward national health objectives. In addition, until recently, reports by the IHS and others have underestimated AI/AN infant mortality rates because of misclassification of race on the death certificate. Although this problem and its solution have been clearly identified,[10–14] few studies have reported AI/AN mortality nationally and stratified by residence location using data linking birth and death certificates.

This study aims to provide a complete picture of the differences in maternal risk, prenatal care use, and birth outcomes between AI/AN populations living in rural and urban counties of the United States, both inside and outside IHS areas.

METHODS

Study Population

This study was based on the 1989–1991 National Linked Birth–Death Database, which constituted the most recent data available from the National Center for Health Statistics (NCHS) at the time the study began in 1997. This database contains selected information, compiled from birth certificates for all 50 states and the District of Columbia, on live births between January 1, 1989, and December 31, 1991. We obtained mother's county-of-residence identifiers for each birth, a method which allowed classification of counties as rural or urban and within or outside IHS areas. Mother's county of residence was the most detailed location available for these births. Death certificate data were linked either by states or the National Center for

Health Statistics to these births if the infant died within a year of birth. Singleton AI/AN births to women who were US residents were included in the study population. An "AI/AN birth" was defined as one in which either the mother or the father was reported as an American Indian or Alaska Native on the birth certificate. This definition method differs from the NCHS's practice (since 1989) of defining race primarily by the race of the mother.[15] We elected to include births of infants with AI/AN fathers because non-AI/AN women giving birth to AI/AN children are likely to be eligible for IHS services. We identified births from other racial groups by the race of the mother only, after excluding those with AI/AN fathers. Whites and African Americans were chosen as reference groups because their prenatal care use and birth outcomes represent the 2 extremes: Whites have some of the most favorable outcomes and African Americans some of the least favorable outcomes.

Definition of Study Variables

Births were classified as either "rural" or "urban" on the basis of the mother's county of residence. Metropolitan statistical area counties were classified as urban; all others were rural. Metropolitan area counties, designated by the US Office of Management and Budget, are those with large cities or urbanized areas, and the adjacent or outlying counties in which substantial proportions of employed individuals commute to the central area for work.[16]

Selected maternal characteristics were categorized to describe the AI/AN births in our study: age (<18, 18–34, >34 years), educational attainment (no high school degree, high school only, 1 or more years of college), marital status (married, other), parity (0, 1–4, 5 or more previous live births), cigarette use (none, <11 cigarettes per day, ≥11 cigarettes per day), alcohol use (none, 1–4 drinks per week, ≥5 drinks per week), history of a prior preterm or small-for-gestational-age infant, preexisting medical conditions (1 or more of the following: maternal cardiac disease, chronic hypertension, and gestational or established diabetes), and complications of pregnancy (1 or more of the following: eclampsia, anemia, oligohydramnios, pregnancy-induced hypertension, incompetent cervix, uterine bleeding, abruptio placentae, and placenta previa).

During analysis, a high degree of correlation was found between marital status and whether the AI/AN parent was the mother or the father. The majority of AI/AN mothers were unmarried, whereas the majority of AI/AN fathers were married. There was a rural/urban difference in the distribution of these births, with urban areas having a much higher proportion of births to couples in which only the father was AI/AN. For this reason, we created a variable to capture the interaction between race of the mother, race of the father, and marital status.

We defined use of prenatal care according to the modified Kessner Index.[18] This index is based on the month prenatal care began and the number of prenatal visits adjusted for gestational age at birth. The modified Kessner Index does not reflect the quality of prenatal care, but rather the pattern of prenatal care received. In this study, the outcome measured was the proportion of births with an inadequate pattern of prenatal care.

Low birthweight was defined as a newborn under 2500 g. Infant deaths were those within 1 year of birth, neonatal deaths were those within 28 days of birth, and postneonatal deaths were those between 29 days and a year of birth. Death rates are presented per 1000 live births.

We examined cause of death for the neonatal and postneonatal periods separately using a modification of the 61 *International Classification of Diseases, 9th Revision* (*ICD-9*)–based categories[19] defined by the NCHS.[20] A number of infectious diseases were aggregated into a single cause-of-death category called "all infectious diseases." Only those causes of death with a rate of 0.01 or more per 1000 births for either rural or urban AI/ANs were examined separately. All others were aggregated into the single category "all other causes."

The IHS classifies each US county as being either inside or outside its geographic administrative area system. Births that occurred in counties inside the IHS administrative areas were designated IHS area births and were subdivided by birth location into the 12 IHS administrative areas. Births that occurred in counties outside the IHS administrative areas were aggregated into a single non–IHS area group.

Analyses

Maternal characteristics, receipt of an inadequate pattern of prenatal care, low-birthweight rates, infant death rates, and cause of death were compared between rural and urban AI/ANs nationally. Chi-square tests were used to compare maternal characteristics and cause-of-death rate ratios. Odds ratios were calculated to compare differences in rural and urban use of prenatal care, low birthweight, and infant death rates for the AI/AN population. Adjusted odds ratios were estimated through multiple logistic regression analyses, with rural/urban maternal residence as the independent variable and receipt of an inadequate pattern of prenatal care, low birthweight, and neonatal, postneonatal, and infant death rates as the dependent variables. These analyses adjusted for a full range of maternal characteristics.

Receipt of an inadequate pattern of prenatal care, low birthweight, and infant death rates for Whites and African Americans are presented for comparison. We used rate ratios to compare causes of death for AI/ANs and non-AI/ANs in rural and urban areas.

Receipt of an inadequate pattern of prenatal care and low-birthweight rates were calculated for rural and urban AI/ANs separately for each of the 12 IHS areas and for the non-IHS area. Adjusted odds ratios comparing rural and urban rates are presented for each of these areas separately. Neonatal and postneonatal death rates were not reported for the 12 IHS areas because of the small number of deaths in each area and consequent unstable death rates.

RESULTS

There were 148 482 AI/AN singleton births between January 1, 1989, and December 31, 1991. Of these births, 75 752 (51%) were to mothers living in rural counties and 72 730 (49%) were to mothers living in urban counties. For both rural and urban areas, the greatest proportion of births were to couples in which only the mother was reported as AI/AN (Table 1). Of

TABLE 1—Sociodemographic and Risk Characteristics of Singleton Rural and Urban American Indian and Alaska Native (AI/AN) Births, 1989–1991

Characteristic	Rural	Urban	Total
Race of parents, %			
Both parents AI/AN	41.3***	17.6	29.7
AI/AN mother only	44.2***	51.8	47.9
AI/AN father only	14.5***	30.7	22.4
Mother's age, %			
<18	7.3***	6.8	7.1
18–34	85.9***	86.5	86.2
≥35	6.8	6.6	6.7
Mother's education, %[a]			
<12 y of school	35.7***	32.5	34.2
12 y of school	44.2***	41.1	42.7
≥1 y of college	20.2***	26.4	23.1
Married, %	49.0***	56.3	52.6
Parity, %[a]			
0	30.9***	37.3	34.0
1–4	63.3***	59.5	61.4
≥5	5.8***	3.2	4.5
Smoking, %[a]			
Nonsmoker	79.5***	76.3	78.1
1–10 cigarettes/day	14.6***	15.4	15.0
≥11 cigarettes/day	5.9***	8.3	6.9
Drinking, %[a]			
Nondrinker	95.8	95.7	95.8
1–4 drinks/wk	3.3	3.4	3.3
≥5 drinks/wk	0.9	0.9	0.9
% with preexisting medical conditions[a,b]	5.1***	3.9	4.5
% with complications of pregnancy[a,c]	13.2***	9.9	11.6
% with prior preterm or SGA infant[a]	2.3***	1.8	2.1
No. of births	75 752	72 730	148 482

[a]Excludes missing data. Percentage of cases with missing data: education, 7.2%; parity, 0.3%; smoking, 27.1%; drinking, 27.2%; preexisting medical conditions, 10.5%; complications of pregnancy, 13.6%; prior preterm or small-for-gestational-age (SGA) infant, 13.5%; age, race, and marital status had no missing data. Not all variables are collected by all states (e.g., 43 states collect smoking status, 44 alcohol use, 47 preexisting conditions and complications of pregnancy). This is reflected in these missing value rates.
[b]Preexisting medical conditions include maternal cardiac disease, chronic hypertension, diabetes.
[c]Complications of pregnancy include eclampsia, anemia, oligohydramnios, pregnancy-induced hypertension incompetent cervix, uterine bleeding, abruptio placentae, placenta previa.
*$P \leq .05$; **$P \leq .01$; ***$P \leq .001$ for differences between rural and urban (2-tailed, 95% confidence level).

the remaining AI/AN births, those in rural areas were significantly more likely to have birth certificates reporting both an AI/AN mother and an AI/AN father, whereas those in urban areas were significantly more likely to have documentation showing an AI/AN father only.

The vast majority of AI/AN births in both rural and urban groups were to women between 18 and 34 years old (Table 1). Approximately half of the births were to unmarried women. Compared with rural mothers, urban mothers were more likely to be unmarried, to be having their first child, and to be smokers. Rural mothers were more likely to have preexisting medical conditions, complications of pregnancy, and a prior preterm or small-for-gestational-age infant.

Rural mothers of AI/AN infants (18.1%) were significantly more likely to have received an inadequate pattern of prenatal care than were urban mothers of AI/AN infants (14.4%), although the difference between these 2 groups decreased when we adjusted for maternal risk characteristics (Table 2). The low-birthweight rate for urban AI/AN births, however, was almost 10% higher than that for rural AI/AN births (5.7% vs 5.2%, $P \leq .001$). With nearly 25 000 births per year in each group, this represents an excess of about 125 low-birthweight urban AI/AN births per year. Overall infant death rates were slightly higher for rural than for urban AI/AN births (not statistically significant), primarily due to the much higher postneonatal death rate of rural AI/AN births (6.7 per 1000) compared with urban AI/AN births (5.4 per 1000). When we adjusted for maternal risk, the difference in postneonatal death rates was not significant at the .05 level ($P = .09$). The adjusted neonatal death rate mirrored the low-birthweight rate and was significantly higher for urban AI/AN births than rural AI/AN births.

More striking are the comparisons between AI/ANs and other racial groups. The rates of receipt of an inadequate pattern of prenatal care (rural=18.1%, urban=14.4%) were comparable to those of African Americans (16.4%) and more than twice the rates of Whites during the same time period (6.8%). In contrast, low-birthweight rates (rural=5.2%, urban=5.7%), although higher than those of Whites (4.7%), were less than half those of African Americans (12.0%). Postneonatal death rates (rural=6.7 per 1000, urban=5.4 per 1000) were more than twice those of Whites (2.6 per 1000) and comparable to those of African Americans (5.8 per 1000). Neonatal death rates mirrored the low-birthweight rates, with the AI/AN rates somewhat higher than the rates for Whites but much lower than the rates for African Americans.

There were no statistically significant rural/urban differences in cause of death among AI/ANs in the neonatal period (table not shown; available upon request). Congenital anomalies, respiratory conditions, and short gestation or low birthweight were the most common causes in both the rural and urban groups and for the non-AI/AN population. Compared with urban non-AI/ANs, urban

TABLE 2—Prenatal Care Receipt and Birth Outcomes of Singleton Rural and Urban American Indians/Alaska Natives and Other Races, 1989–1991

	American Indians/Alaska Natives					
	Rural, %	Urban, %	Rural to Urban Unadjusted Odds Ratio (95% CI)	Rural to Urban Adjusted Odds Ratio[a] (95% CI)	Whites, %	African Americans, %
% who received inadequate pattern of prenatal care	18.1	14.4	1.31*** (1.28, 1.35)	1.03* (1.00, 1.07)	6.8	16.4
% low birthweight (<2500 g)	5.2	5.7	0.90*** (0.86, 0.95)	0.89*** (0.85, 0.93)	4.7	12.0
Mortality (rate/1000)						
Neonatal (0–28 days)	5.0	5.5	0.94 (0.81, 1.08)	0.85* (0.73, 0.99)	4.0	9.8
Postneonatal (29 days–1 year)	6.7	5.4	1.23** (1.08, 1.41)	1.13 (0.98, 1.30)	2.6	5.8
Infant death (first-year total)	11.7	11.0	1.09 (0.99, 1.20)	0.99 (0.89, 1.10)	6.7	15.6
No. of births[b]	75 752	72 730	NA	NA	9 469 966	1 983 611

Note. CI = confidence interval; NA = not applicable.
[a]Multiple logistic regression adjusted for race/marital status, age, parity, education, complications of pregnancy, preexisting conditions, prior preterm or small-for-gestational-age infant, smoking, and drinking, except for the prenatal care regression, which adjusted for all variables except smoking and drinking.
[b]When receipt of an inadequate pattern of prenatal care percentages was calculated, the births with missing values for this variable were excluded (rural American Indian/Alaska Native n = 73 081, urban American Indian/Alaska Native n = 68 198, White n = 9 112 958, African American n = 1 859 810).
*$P \leq .05$; **$P \leq .01$; ***$P \leq .001$ for significance of odds ratios from 1 (i.e., no difference) (2-tailed, 95% significance level).

AI/ANs were significantly less likely to die from short gestation or unspecified low birthweight–related disorders in the neonatal period (rate ratio = 0.74). Urban AI/AN infants were significantly more likely than urban non-AI/AN infants to die in the neonatal period from complications of the umbilical cord, membranes, or placenta (rate ratio = 1.48); infections specific to the perinatal period (rate ratio = 2.08); and infectious diseases (rate ratio = 2.06). Rural AI/AN infants were more likely than rural non-AI/AN infants to die in the neonatal period from infectious diseases (rate ratio = 2.10) and unintentional injuries (rate ratio = 3.34).

The causes of death shifted in the postneonatal period, with the most common causes for both AI/AN and non-AI/AN infants being sudden infant death syndrome (SIDS), infectious diseases, congenital anomalies, and unintentional injuries (table not shown; available upon request). Rural AI/AN postneonatal deaths were significantly more likely than urban AI/AN postneonatal deaths to be caused by infectious diseases (rate ratio = 1.89) and unintentional injuries (rate ratio = 1.82). Much more dramatic differences were seen between AI/AN and non-AI/AN postneonatal death rates in both rural and urban areas. The postneonatal death rates from SIDS and unintentional injuries for rural and urban AI/ANs were over twice those for non-AI/ANs (rate ratio = 2.05 and 2.42, respectively). Postneonatal deaths from infectious diseases were also significantly higher for both rural and urban AI/ANs than for non-AI/ANs (rate ratios = 2.76 and 1.57, respectively). Rural AI/ANs had higher postneonatal death rates for congenital anomalies than did rural non-AI/ANs (rate ratio = 1.49), whereas urban AI/ANs had higher postneonatal death rates for homicide (rate ratio = 2.44) and respiratory distress syndrome (rate ratio = 2.46) than did urban non-AI/ANs.

Table 3 compares the rates of receipt of an inadequate pattern of prenatal care and low birthweight among the rural and urban residents of the 12 IHS areas and the non-IHS counties. Nearly half of the urban AI/AN births (48.7%) and a substantial proportion of rural AI/AN births (15.3%) were to women living in counties outside IHS areas. In general, Table 3 demonstrates as much or more variation in our study measures between the different IHS areas (e.g., between rural Phoenix and rural Alaska) as between rural and urban counties within individual IHS areas (e.g., between rural Oklahoma and urban Oklahoma). For example, 25.6% of Aberdeen Area's rural births had been to mothers receiving an inadequate pattern of prenatal care, in contrast to 10.7% of Alaska Area's rural births, more than a twofold difference. The largest difference within an IHS area was in Bemidji, where the rural receipt of an inadequate pattern of prenatal care was 17.1%, urban 10.5%. In four IHS areas, receipt of an inadequate pattern of prenatal care was significantly higher in urban areas than rural areas. In another four IHS areas, this pattern was reversed, with receipt of an inadequate pattern of prenatal care higher in rural areas than urban areas. There was less variation in low birthweight rates between rural and urban areas within individual IHS areas. The adjusted odds of low birthweight was either the same or lower for rural compared to urban counties in all individual IHS areas.

DISCUSSION

This study confirms the findings of other work documenting the high rates of receipt of an inadequate pattern of prenatal care and of infant death, especially postneonatal death, among AI/ANs.[2,8,21] It also elucidates several significant differences between AI/ANs living in rural and urban areas.

Both rural and urban AI/ANs were 2 to 3 times more likely than Whites and about as likely as African Americans to receive an inadequate pattern of prenatal care. Within the AI/AN population, rural AI/ANs have higher rates of receipt of an inadequate pattern of prenatal care than do urban AI/ANs,

TABLE 3—Prenatal Care Receipt and Low-Birthweight Rates of American Indians/Alaska Natives by Rural/Urban Residence and Indian Health Service (IHS) Area, 1989–1991

	No. of Births		% Who Received Inadequate Pattern of Prenatal Care[b]			% Low Birthweight (< 2500 g)		
IHS Area[a]	Rural	Urban	Rural	Urban	Adjusted Rural-to-Urban OR[c] (95% CI)	Rural	Urban	Adjusted Rural-to-Urban OR[c] (95% CI)
Aberdeen	6858	1475	25.6	20.3	1.17* (1.01, 1.36)	5.0	6.0	0.76* (0.59, 0.98)
Navajo	19 552	NA	23.9	NA	NA	5.6	NA	NA
Phoenix	2380	6547	21.4	22.3	1.01 (0.89, 1.14)	5.2	5.1	1.07 (0.86, 1.34)
Albuquerque	2151	2921	20.0	21.9	0.85* (0.73, 0.99)	5.8	5.2	1.12 (0.87, 1.45)
Billings	4209	385	18.9	27.1	0.54*** (0.47, 0.70)	5.0	4.7	1.02 (0.60, 1.73)
Bemidji	4189	1053	17.1	10.5	1.66*** (1.32, 2.08)	4.5	4.4	0.99 (0.70, 1.41)
Oklahoma	10 125	7489	16.5	14.5	1.04 (0.95, 1.14)	4.6	5.0	0.96 (0.83, 1.11)
California	2181	5832	16.4	12.5	1.19* (1.02, 1.39)	4.6	5.6	0.76* (0.60, 0.97)
Portland	3611	6225	14.4	16.2	0.74*** (0.65, 0.85)	4.6	5.2	0.93 (0.75, 1.15)
Alaska	7164	1832	10.7	7.5	1.36** (1.11, 1.66)	4.3	5.4	0.84 (0.65, 1.08)
Nashville	1767	1949	9.9	10.3	0.65** (0.57, 0.85)	4.8	6.0	0.59** (0.42, 0.82)
Tucson	2	1623	–[d]	15.0	–[d]	–[d]	4.8	–[d]
All non-IHS counties	11 563	35 399	11.7	12.7	0.82*** (0.77, 0.88)	6.1	6.3	0.99 (0.90, 1.09)
Total	75 752	72 730	18.1	14.4	1.03* (1.00, 1.07)	5.2	5.7	0.89*** (0.85, 0.93)

Note. OR = odds ratio; CI = confidence interval; NA = not applicable.

[a]IHS areas included 1 or more counties of the following states in the period 1989 to 1991: Aberdeen—Minnesota, North Dakota, Nebraska, South Dakota; Navajo—Arizona, New Mexico, Utah; Phoenix—Arizona, California, Colorado, Idaho, Nevada, Oregon, Utah; Albuquerque—Colorado, New Mexico, Texas, Utah; Billings—Montana, Wyoming; Bemidji—Michigan, Minnesota, Wisconsin; Oklahoma—Kansas, Nebraska, Oklahoma, Texas; California—California; Portland—Idaho, Oregon, Washington; Alaska—Alaska; Nashville—Alabama, Connecticut, Florida, Louisiana, Maine, Massachusetts, Mississippi, North Carolina, New York, Pennsylvania, Rhode Island, Texas; Tucson—Arizona.

[b]Percentages exclude missing data (rural n = 73 081, urban n = 68 198).

[c]Multiple logistic regression adjusted for race/marital status, age, parity, education, complications of pregnancy, preexisting conditions, prior preterm or small-for-gestational-age infant, smoking, and drinking, except for the prenatal care regression, which adjusted for all variables except smoking and drinking.

[d]Inadequate number of births to calculate.

$^{*}P \leq .05$; $^{**}P \leq .01$; $^{***}P \leq .001$ for significance of odds ratios from 1 (i.e., no difference) (2-tailed, 95% significance level).

despite the fact that a greater proportion of rural AI/ANs live within IHS areas, where health care services are funded by the IHS. This situation may reflect barriers to optimal care (e.g., greater distances from health services, limited transportation systems in rural areas) that interfere with women's receipt of prenatal care. Whereas national figures demonstrate a less adequate pattern of prenatal care receipt for rural AI/ANs, we found substantial variation between IHS areas, with several areas showing a less adequate pattern of prenatal care receipt for urban AI/ANs. Further examination of IHS areas with better and worse prenatal care receipt may help identify the sources of these differences. Findings of studies examining the effect of prenatal care on birthweight have been mixed, with some studies suggesting that increasing prenatal care use does not decrease low-birthweight rates.[22–26] Nonetheless, prenatal care serves many important functions. Ensuring equitable access to adequate prenatal care for all women is crucial. Solutions to improve prenatal care use must be tailored to address the barriers specific to a geographic area as well as to the local AI/AN population.

Low-birthweight rates for both rural and urban AI/ANs were higher than those for Whites, although this difference was less dramatic than that seen with the inadequate-pattern-of-prenatal-care rates. In contrast to the findings for prenatal care use, urban AI/ANs were more likely than rural AI/ANs to have low-birthweight infants. These findings suggest that factors other than the amount of prenatal care received play important roles in the determination of birthweight. In addition, there may be unidentified sociodemographic or risk differences between urban and rural AI/AN births. As would be expected, the neonatal death rates of rural and urban AI/ANs mirrored the low-birthweight rates, with urban AI/ANs demonstrating a higher neonatal death rate than rural AI/ANs.

The most troubling finding of this study is the confirmation of very high postneonatal death rates for both rural and urban AI/ANs, more than twice that of Whites. Although reports of high AI/AN postneonatal death rates are not new,[27–29] this study also demonstrated a significantly higher postneonatal death rate among rural compared with urban AI/ANs, especially for infectious diseases and unintentional injuries. Within rural areas and in comparison with the non-AI/AN US population, AI/ANs have substantially higher rates of postneonatal death from a number of preventable causes: SIDS, infectious diseases, and unintentional injuries. Within urban areas, SIDS, infectious diseases, unintentional injuries, and homicide are all higher for AI/ANs than for the non-AI/AN population. These higher death rates from preventable causes suggest that opportunities exist to reduce the postneonatal death rates of rural and urban AI/ANs through improved access to health services, health education, and prevention programs targeted at injury prevention, sleep position and conditions, and prevention and management of febrile illnesses.

Although dramatic improvements in AI/AN maternal and child health have been documented over the last few decades, the findings of this study demonstrate that significant unmet health care needs remain for both rural and urban AI/ANs. The increases allocated by Congress in the IHS budget have not kept up with rising medical costs, so that the level of service relative to need for AI/ANs may actually have decreased over time. Surprisingly, several of the health status measures examined in this study appeared worse in rural areas, even though the IHS has greater health service coverage in rural areas than in urban areas. However, greater distances from services and a higher degree of poverty in rural areas[8] may make it more difficult for rural AI/ANs to take advantage of available health and preventive services. At the same time, urban AI/ANs may have better access to health services through private insurance, Medicaid, or other programs. This possibility does not help explain the higher low-birthweight and neonatal death rates for urban AI/ANs, however, and further investigation is needed to explain these findings.

This study provides important information about the urban segment of the AI/AN population, a group that is difficult to study given its dispersion and the misclassification of AI/ANs in health databases and reports. Although urban AI/ANs appear to have better access to prenatal services and lower postneonatal death rates than do their rural counterparts, their rates of receipt of an inadequate pattern of prenatal care, low birthweight, and neonatal and postneonatal death are still much higher than those of urban Whites, confirming their need for improved services. Further research is needed to characterize urban AI/ANs' access to health services through the IHS-funded urban AI/AN programs, tribal health programs, private insurance, or other programs.

This study's limitations include those common to studies that use secondary databases. Birth certificates in particular experience both missing data—as evidenced by the high rates of missing data in our database for cigarette use, alcohol use, and maternal and obstetric risk characteristics (Table 1)—and underreporting of variables such as alcohol use, history of a prior preterm or small-for-gestational-age infant, and pregnancy complications.[30–33] Prenatal visits are also underreported on birth certificates.[34] The available residence location was county. Single counties can include both rural and urban areas, however, so our rural/urban definition likely includes some misclassification. Because birth certificates are generally completed in hospitals, differences in accuracy or completion rates by rural and urban hospitals could affect our study results.

In addition, the results from this analysis of decade-old data are now dated and may not be representative of the current situation. However, these data were the most current available at the time this study was begun in 1997. As such, they establish a baseline from which to measure change and are useful in framing many questions. Last, our use of the modified Kessner Index provided a conservative measure of receipt of an inadequate pattern of prenatal care. This measure depends more on the timing of initiation of prenatal care than do alternative measures. Although use of the newer measures would result in higher rates of receipt of an inadequate pattern of prenatal care for all study groups, we would not expect the relationship in rates between the study groups to change.

Since the time period of this study, increasing numbers of tribes have assumed responsibility for managing their own health care systems,[6] which could be associated with changes in some of the study's outcome measures. More recent regional data from the Pacific Northwest suggest that AI/AN infant mortality rates improved during the mid-1990s, particularly with regard to deaths caused by SIDS.[35] However, it is not known whether these improvements are generalizable to AI/ANs elsewhere or whether the gains are equally distributed among urban and rural AI/ANs. In addition, even within a single geographic region, there can be great diversity between tribes in these rates. Clearly, it is important to replicate this study with the national linked birth–death data that have recently become available, both to update these findings and to examine changes over the last decade.

Prior studies, including those resulting in recently published IHS figures on infant mortality,[2,36] have suffered from the well-documented problem of misclassification of race on the death certificate, which results in an underestimate of AI/AN infant death rates.[12–14,37–39] Our study's use of linked birth–death records to identify AI/AN deaths minimized this misclassification problem and has allowed us to provide national and IHS area–based infant mortality rate figures that are both higher and more accurate than those previously reported.

In summary, we found high rates of receipt of an inadequate pattern of prenatal care and of postneonatal infant death for both rural and urban AI/ANs compared with Whites. In addition, the results document substantial variation across IHS areas in maternal and child health measures. The patterns are complex and pose more questions than they seem to answer. Community-driven programs must be developed locally, both to review outcome measures such as these and to devise the most appropriate strategies to address the unmet needs of rural and urban AI/ANs. Development of data systems, such as those provided by the IHS-funded Tribal Epidemiology Centers, that can supply information at the local level is crucial to effective health and social service program planning by tribes that have assumed responsibility for their members' health care needs, the IHS, and others involved in providing AI/AN health services. ■

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Contributors

L.-M. Baldwin and L.G. Hart conceived and designed the original study. L.-M. Baldwin supervised the study analysis and wrote the initial draft of the article. L.-M. Baldwin, D.C. Grossman, S. Casey, and L.G. Hart refined the study methodology and analysis plan. S. Casey conducted the analyses. W. Hollow, J.R. Sugarman, and W.L. Freeman met as part of an advisory panel with the other study authors to provide input on the study methodology and analysis plan, review the study results, help interpret the study findings, and review, revise, and edit the article.

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References

1. Rhoades ER, Hammond J, Welty TK, Handler AO, Amler RW. The Indian burden of illness and future health interventions. *Public Health Rep.* 1987;102:361–368.

2. *Trends in Indian Health.* Rockville, Md: Indian Health Service; 1997.

3. Waxman AG. Patterns of natality and infant and maternal mortality. In: Galloway JM, Goldberg BW, Alpert JS, eds. *Primary Care of Native American Patients: Diagnosis, Therapy, and Epidemiology.* Boston, Mass: Butterworth-Heinemann; 1999.

4. *Regional Differences in Indian Health 1997.* Rockville, Md: Indian Health Service; 1997.

5. *1990 Census of Population, General Population Characteristics, United States.* Washington, DC: Bureau of the Census; 1992.

6. Kunitz SJ. The history and politics of US health care policy for American Indians and Alaskan Natives. *Am J Public Health.* 1996;86:1464–1473.

7. Indian Health Service. Indian health programs budget. Available at: www.ihs.gov/adminmngrresources/budget/old_site/tools/2001budovr.pdf. Accessed June 4, 2002.

8. Grossman DC, Krieger JW, Sugarman JR, Forquera RA. Health status of urban American Indians and Alaska Natives. A population-based study. *JAMA.* 1994;271:845–850.

9. Sugarman JR, Brenneman G, LaRoque W, Warren CW, Goldberg HI. The urban American Indian oversample in the 1988 National Maternal and Infant Health Survey. *Public Health Rep.* 1994;109:243–250.

10. Classification of American Indian race on birth and infant death certificates—California and Montana. *MMWR Morb Mortal Wkly Rep.* 1993;42:220–223.

11. Kennedy RD, Deapen RE. Differences between Oklahoma Indian infant mortality and other races. *Public Health Rep.* 1991;106:97–99.

12. Frost F, Shy KK. Racial differences between linked birth and infant death records in Washington State. *Am J Public Health.* 1980;70:974–976.

13. Frost F, Tollestrup K, Ross A, Sabotta E, Kimball E. Correctness of racial coding of American Indians and Alaska Natives on the Washington State death certificate. *Am J Prev Med.* 1994;10:290–294.

14. Hahn RA, Mulinare J, Teutsch SM. Inconsistencies in coding of race and ethnicity between birth and death in US infants. A new look at infant mortality, 1983 through 1985. *JAMA.* 1992;267:259–263.

15. 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: US Dept of Health and Human Services; 1995:5–6.

16. Ricketts TC, Johnson-Webb KD, Randolph RK. Populations and places in rural America. In: Ricketts TC, ed. *Rural Health in the United States.* New York, NY: Oxford University Press; 1999:7–24.

17. *Linked Birth/Infant Death Data Set: 1989 Birth Cohort.* Hyattsville, Md: US Dept of Health and Human Services; 1995.

18. *International Classification of Diseases, 9th Revision.* Geneva, Switzerland: World Health Organization; 1980.

19. 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: US Dept of Health and Human Services; 1995:8–11.

20. Buck GM, Mahoney MC, Michalek AM, Powell EJ, Shelton JA. Comparison of Native American births in upstate New York with other race births, 1980–86. *Public Health Rep.* 1992;107:569–575.

21. Piper JM, Mitchell EF Jr, Ray WA. Expanded Medicaid coverage for pregnant women to 100 percent of the federal poverty level. *Am J Prev Med.* 1994;10:97–102.

22. Kaestner R. Health insurance, the quantity and quality of prenatal care, and infant health. *Inquiry.* 1999;36:162–175.

23. Long SH, Marquis MS. The effects of Florida's Medicaid eligibility expansion for pregnant women. *Am J Public Health.* 1998;88:371–376.

24. Kogan MD, Martin JA, Alexander GR, Kotelchuck M, Ventura SJ, Frigoletto FD. The changing pattern of prenatal care utilization in the United States, 1981–1995, using different prenatal care indices. *JAMA.* 1998;279:1623–1628.

25. Misra DP, Guyer B. Benefits and limitations of prenatal care: from counting visits to measuring content. *JAMA.* 1998;279:1661–1662.

26. Vanlandingham MJ, Hogue CJ. Birthweight-specific infant mortality risks for Native Americans and whites, United States, 1960 and 1984. *Soc Biol.* 1995;42:83–94.

27. Nakamura RM, King R, Kimball EH, Oye RK, Helgerson SD. Excess infant mortality in an American Indian population, 1940 to 1990. *JAMA.* 1991;266:2244–2248.

28. Vanlandingham MJ, Buehler JW, Hogue CJ, Strauss LT. Birthweight-specific infant mortality for native Americans compared with whites, six states, 1980. *Am J Public Health.* 1988;78:499–503.

29. Woolbright LA, Harshbarger DS. The revised standard certificate of live birth: analysis of medical risk factor data from birth certificates in Alabama, 1988–92. *Public Health Rep.* 1995;110:59–63.

30. Piper JM, Mitchell EF, Snowden M, Hall C, Adams M, Taylor P. Validation of the 1989 Tennessee birth certificates using maternal and newborn hospital records. *Am J Epidemiol.* 1993;137:758–768.

31. Parrish KM, Holt VL, Connell FA, Williams B, LoGerfo P. Variations in the accuracy of obstetric procedures and diagnoses on birth records in Washington State, 1989. *Am J Epidemiol.* 1993;138:119–127.

32. Buescher PA, Taylor KP, Davis MH, Bowling JM. The quality of the new birth certificate data: a validation study in North Carolina. *Am J Public Health.* 1993;83:1163–1165.

33. Dobie SA, Baldwin L-M, Rosenblatt RA, Fordyce MA, Andrilla CHA, Hart LG. How well do birth certificates describe the pregnancies they report? The Washington State experience with low-risk pregnancies. *Matern Child Health J.* 1998;2:145–154.

34. Decrease in infant mortality and sudden infant death syndrome among Northwest American Indians and Alaskan Natives—Pacific Northwest, 1985–1996. *MMWR Morb Mortal Wkly Rep.* 1999;48:181–184.

35. *Regional Differences in Indian Health 1996.* Rockville, Md: Indian Health Service; 1996.

36. Epstein M, Moreno R, Bacchetti P. The underreporting of deaths of American Indian children in California, 1979 through 1993. *Am J Public Health.* 1997;87:1363–1366.

37. Querec L. *Measuring Underreporting of American Indian Infant Mortality: Methodology and Findings. Based on the Linked Birth/Infant Death Data Sets, 1983–1987.* Rockville, Md: US Dept of Health and Human Services; 1994.

38. *Final Report: Methodology for Adjusting IHS Mortality Data for Inconsistent Classification of Race-Ethnicity of American Indians and Alaska Natives Between State Death Certificates and IHS Patient Registration Records.* Silver Spring, Md: Support Services International Inc; 1996.