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Infant Mortality in American Indians and Alaska Natives 1995–1999 and 2000–2004

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Abstract: **Objectives**. (1) To determine the infant mortality rate (IMR) in American Indians/Alaska Natives (AI/AN) and Whites between 1995–1999 and 2000–2004. (2) To compare the leading causes of infant mortality in AI/AN and Whites. (3) To examine differences in neonatal *vs*. postneonatal causes of death in Whites and AI/AN. **Methods**. Using the 1995–99 and 2000–04 Centers for Disease Control and Prevention's National Center for Health Statistics national linked birth/infant death data, we examined neonatal and postneonatal IMR among AI/AN and Whites. **Results**. AI/AN experienced significantly greater overall IMR in 1995–1999 and 2000–2004 than Whites. While the reduction in the IMR between these time periods was statistically significant for Whites, the reduction among AI/AN was not. We found that AI/AN had an IMR 1.5 times as high as that of Whites. **Conclusions**. While the overall IMR has decreased in AI/AN, disparities in postneonatal IMR persist between AI/AN and Whites.

Key words: Health disparities, infant mortality, American Indian, Alaska Native.

Infant mortality remains a worldwide indicator of social well-being and an important measure of a nation's health. Through initiatives such as *Healthy People 2010* and *2020* and *Closing the Health Gap Campaign on Infant Mortality*, The U.S. Department of Health and Human Services (HHS) has highlighted infant mortality as a critical barometer of the nation's health where significant racial and ethnic health disparities persist.[1,2] American Indians and Alaska Natives (AI/AN) experience health disparities in the form higher infant mortality rates relative to Whites.[3]

While the infant mortality rate in AI/AN has drastically improved since 1955 when the infant mortality rate was 62.7 per 1,000 live births, to 9.22 per 1,000 live births in 2007, significant disparities exist between AI/AN and Whites.[3–8] In 2007 the infant mortality rate for AI/AN was nearly 1.5 times higher than that of Whites. Studies of trends in AI/AN and Whites have found that while birth-weight specific infant mortality rates declined in AI/AN and White infants between the intervals of 1989–1991

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and 1998–2000, the latter cohort of AI/AN infants had a 1.7 times higher likelihood of dying than White infants; furthermore, the infant mortality rate among AI/AN follows a different pattern from any other U.S. subpopulation in that nationally, AI/AN experience a disproportionate burden of the postneonatal infant mortality rate as a proportion of the total infant mortality rate. This pattern is described in populations living in developing economies and is uniquely different from infant mortality rates in other minority populations in the U.S. who experience proportionately higher neonatal infant mortality rates.[8,9] Data indicate that in both described time intervals approximately half of all AI/AN infant deaths occurred in the post-neonatal period, in comparison to about 40% or less in Whites.[3] Previous studies have attributed the elevated neonatal IMR in AI/AN primarily to accidents, pneumonia, and influenza.[3,10]

With the development of interventions that target high-risk AI/AN communities, monitoring the infant mortality rate in this population remains important as does assessing preventable underlying causes for infant death. However, one primary challenge to monitoring and comparing the IMR of AI/AN with that of other racial groups remains the relatively small number of AI/AN births/deaths per year. With this limitation in mind we used five-year time intervals to calculate infant mortality rates in American Indians. The specific aims of this study are:

1. To compare the leading causes of infant mortality in AI/AN and Whites.
2. To examine differences in neonatal *vs*. postneonatal causes of death in Whites and AI/AN.

Methods

We used birth and infant death certificate data from the Centers for Disease Control and Prevention's National Center for Health Statistics (NCHS) national linked birth/infant death data file for birth cohorts during 1995–2004. The dataset for each of these years contains data on all births during the year (denominator) and all deaths within the first 364 days linked to those births (numerator). At the time of the study, the most recently available linked birth cohort data came from the 2004 data file. The data files employed in the analysis included information compiled from the 50 United States and the District of Columbia. We defined the race of the infant by the mother's race on the birth certificate and included singleton births of AI/AN and White women in our analysis. Since 1995, the NCHS linked birth/infant death data files have included weighted adjustments for the numerator in order to account for those deaths not linked to a birth certificate. Weights were calculated by age at death and state by adding linked and unlinked infant deaths, and dividing by linked infant deaths.[4] Our analysis incorporates this weighted adjustment. The study population for the 1995–1999 period included 194,209 AI/AN and 15,532,522 White birth infant records and 1,798 AI/AN and 93,660 White linked deaths. The 2000–2004 period included 205,939 AI/AN and 15,242,838 White birth records and 1,802 AI/AN and 87,382 White linked infant deaths.

Cause-specific infant mortality rates were defined as infant death per 1,000 live births. We used SAS 9.1.3 to conduct the analyses (copyright © [2003] SAS Institute Inc. SAS and all other SAS Institute Inc. product or service names are registered trademarks

or trademarks of SAS Institute Inc., Cary, NC, USA). We calculated infant mortality rates in infancy (0–364 days) and in neonatal (0–27 days) and postneonatal (28–364 days) time periods and compared these rates between AI/AN and Whites. Data from 1995–1999 and 2000–2004 were combined and rates were calculated by multiplying the number of linked deaths by 1,000 and dividing by the number of births over the cohort years. Cause of postneonatal death was determined based upon the death certificate and each observation was assigned to individual and aggregate categories as defined by the *International Classification of Diseases, Ninth and Tenth Revisions (ICD-9 and ICD-10)* grouping.[11,12] Due to the 1999 replacement of ICD-9 to ICD-10, ICD-9 codes were translated to the 130 selected causes of infant death according to NCHS's published methods.[13]

Ranks for causes of death were determined based upon the cause-specific mortality rate (per 1,000 live births). Statistical tests were applied to compare rates according to the methods described by Mathews *et al*. For calculations in which the numerator was equal to/greater than 100, a binomial distribution was assumed to determine standard error. A Poisson distribution was assumed for all calculations in which the numerator was less than 100. P-values and 95% confidence intervals were calculated accordingly.[14]

Results

AI/AN experienced significantly greater overall infant mortality rates in 1995–1999 and 2000–2004 than Whites (see Table 1). While the reduction in the infant mortality rate between these time periods was statistically significant for Whites, the reduction among AI/AN was not. The degree of disparity between AI/AN and Whites did not change significantly between these time periods. Using relative risk ratios we found that AI/AN had an infant mortality rate 1.5 times as high as that of Whites.

Table 1.

NEONATAL AND POSTNEONATAL INFANT MORTALITY RATES (IMR) AMONG SINGLETON INFANTS BY RACE: UNITED STATES, 1995–1999, 2000–2004[a]

	1995–1999 infant mortality rate (IMR)			2000–2004 IMR		
	White	AI/AN	p-value	White	AI/AN	p-value
Neonatal	3.98 (66%)	4.64 (50%)	p<.0001	3.83 (67%)	4.41 (50%)	p<.0001
Postneonatal	2.05 (34%)	4.62 (50%)	p<.0001	1.89 (33%)	4.35 (50%)	p<.0001
Overall IMR	6.03	9.26	P<.001	5.72	8.76	P<.001

[a]Rates are expressed as per 1,000 live births. (Percentage reflects the proportion of infant mortality deaths that take place in the neonatal and postneonatal time period)
AI=American Indians
AN=Alaska Natives

AI/AN and Whites shared the same leading three causes of death in infant mortality in both time periods: congenital malformations, deformations, and chromosomal abnormalities; disorders related to short gestation and low birthweight not classified elsewhere; and sudden infant death syndrome (SIDS). However, in 1995–1999, SIDS remained the leading cause of death in AI/AN while this condition occupied third place among Whites. In 2000–2004, while still occupying the third most common cause of death in Whites, SIDS became the second leading cause of death in AI/AN infants, while congenital malformations, deformations, and chromosomal abnormalities represented the most common cause of death in both AI/AN and Whites (see Table 2).

The neonatal all-cause mortality rate was significantly higher in AI/AN in 1995–1999 and 2000–2004, and only Whites experienced a significant reduction in neonatal mortality between these time periods. In 1995–1999 AI/AN and Whites shared the same top three leading three causes of neonatal mortality by rank: 1. congenital malformations, deformations, and chromosomal abnormalities; 2. disorders related to short gestation and low birthweight not classified elsewhere; 3. other respiratory conditions originating in the perinatal period. In 2000–2004, AI/AN and White shared the same top three leading causes by rank: 1. congenital malformations, deformations, and chromosomal abnormalities; 2. disorders related to short gestation and low birthweight not classified elsewhere; 3. newborn affected by maternal complications of pregnancy. In both time frames, in comparison to Whites AI/AN experienced significantly higher rates of death from 1. congenital malformations, deformations, and chromosomal abnormalities; and 2. disorders related to short gestation and low birthweight not classified elsewhere (see Table 3).

The postneonatal all-cause mortality rate was significantly higher in AI/AN in 1995–1999 and 2000–2004, and only Whites experienced a significant decrease in postneonatal mortality between these time periods. Sudden infant death syndrome remained the leading cause of death in postneonatal mortality in AI/AN and Whites, with congenital malformations, deformations, and chromosomal abnormalities as the second cause of death in both races. Both groups experienced a significant decrease in mortality from SIDS from 1995–1999 to 2000–2004; however, the rate of postneontatal mortality from SIDS remained 2.7 times higher in AI/AN in comparison with Whites during both time intervals, and accounted for 34% and 26% of all postneonatal deaths in AI/AN in 1995–1999 and 2000–2004, respectively. Among AI/AN, in 1995–1999 the third, fourth and fifth leading causes of postneonatal mortality included 3. other symptoms, signs, and abnormal clinical laboratory (0.40/1000 live births); 4. Accidents (0.33/1000 live births); and 5. viral diseases (0.31/1000 live births). In 2000–2004, in the same population, the third, fourth, and fifth leading causes of death included: 3. Accidents (0.53/1000 live births); 4. other symptoms, signs, and abnormal clinical laboratory (0.51/1000 live births); and 5. diseases of the respiratory system (0.37/1000 live births). (See Table 4.)

In comparison with Whites, AI/AN were 2.4 and 3.0 times as likely to die from accidents in 1995–1999 and 2000–2004, respectively; furthermore, AI/AN were 3.4 and 3.2 times more likely than Whites to die from diseases of the respiratory system in 1995–1999 and 2000–2004 respectively.

While there was an increase in postneonatal deaths from congenital malformations from 95 to 132 (0.49/1,000 to 0.62/1,000)(p=.008) and diseases of the respiratory

Table 2.

INFANT DEATHS AND MORTALITY RATES AMONG SINGLETON INFANTS FOR THE FIVE LEADING CAUSES OF INFANT DEATH, BY RACE: UNITED STATES, 1995–1999, 2000–2004[a]

	1995–1999 infant mortality rate (IMR)							2000–2004 IMR						
	White			AI/AN				White			AI/AN			
Common Origination and Disbursement	Rank	No	Rate	Rank	No	Rate	p-value	Rank	No	Rate	Rank	No	Rate	p-value
All causes	NA	93660	6.03	NA	1798	9.26	p<.0001	NA	91551	5.71	NA	1864	8.75	p<.0001
118–133 Congenital malformations, deformations, and chromosomal abnormalities	1	23942	1.54	2	332	1.71	p=.0695	1	21606	1.35	1	378	1.76	p<.0001
088–90 Disorders related to short gestation and low birth weight not elsewhere classified	2	10871	.70	3	168	.86	p=.0083	2	12786	.80	3	198	.93	p=.0396
135 Sudden infant death syndrome	3	9821	.63	1	334	1.72	p<.0001	3	7548	.47	2	261	1.23	p<.0001
074–078 Newborn affected by maternal complications of pregnancy								4	4908	.31				p=.6042
136 Other symptoms, signs and abnormal clinical and laboratory				5	94	.48	p<.0001				4	125	.59	p<.0001
139–151 Accidents											5	119	.56	p<.0001
012–018 Viral diseases	5	5049	.33	4	103	.53	p<.0001							
097–104 Other respiratory conditions originating in the perinatal period	4	5567	.36				p=.8670	5	4299	27				p=.9874

[a]Rates are expressed as per 1,000 live births. The following ICD codes are not included in the Table 2: 116–117 Hydrops fetalis not due to hemolytic disease; 134 Symptoms, signs and abnormal clinical laboratory findings, not elsewhere classified; 086 Disorders related to length of gestation and fetal malnutrition; and 071–073 Newborn affected by maternal factors and complications of pregnancy labor and delivery.

AI=American Indians

AN=Alaska Natives

Table 3.

NEONATAL DEATHS AND MORTALITY RATES AMONG SINGLETON INFANTS FOR THE FIVE LEADING CAUSES OF INFANT DEATH, BY RACE: UNITED STATES, 1995–1999, 2000–2004[a]

	1995–1999 infant mortality rate (IMR)							2000–2004 IMR						
	White			AI/AN				White			AI/AN			
Common Origination and Disbursement	Rank	No	Rate	Rank	No	Rate	P-value	Rank	No	Rate	Rank	No	Rate	P-value
All causes	—	61792	3.98	—	901	4.64	p<.0001	—	613345	3.83	—	938	4.41	p<.0001
118–133 Congenital malformations, deformations, and chromosomal abnormalities	1	17625	1.14	1	236	1.22	p=.2961	1	15739	.98	1	244	1.15	p=.0170
088–90 Disorders related to short gestation and low birth weight not elsewhere classified	2	10705	.69	2	166	.85	P=.0076	2	12543	.78	2	194	.91	p=.0434
074–078 Newborn affected by maternal complications of pregnancy	4	4102	.26	5	56	.29	p=.6056	3	4877	.30	3	62	.29	p=.6389
117 Other perinatal conditions								4	3643	.23	5	54	.25	p=.5119
097–104 Other respiratory conditions originating in the perinatal period	3	4674	.30	3	58	.30	p=.8514	5	3483	.22				p=.5882
012–018 Viral Diseases	5	3731	.24				p=.5965							
079–085 Newborn affected by complications of placenta cord and membranes				4	56	.29	p=.0083				4	59	.28	p=.0752

[a]Rates are expressed as per 1,000 live births.
AI=American Indians
AN=Alaska Natives

Table 4.

POSTNEONATAL DEATH AND MORTALITY RATES AMONG SINGLETON INFANTS FOR THE FIVE LEADING CAUSES OF INFANT DEATH, BY RACE: UNITED STATES, 1995–1999, 2000–2004[a]

	1995–1999 infant mortality rate (IMR)							2000–2004 IMR						
	White			AI/AN				White			AI/AN			
Common Origination and Disbursement	Rank	No	Rate	Rank	No.	Rate	P-value	Rank	No	Rate	Rank	No	Rate	P-value
All causes	—	31868	2.05	—	897	4.62	p=.0001	—	30216	1.89	—	926	4.35	p=.0001
135 Sudden infant death syndrome	1	9142	.59	1	304	1.57	p=.0001	1	6872	.43	1	243	1.14	p=.0001
118–133 Congenital malformations, deformations, and chromosomal abnormalities	2	6317	.41	2	95	.50	p=.0739	2	5867	.37	2	132	.62	p=.0001
136 Other symptoms, signs and abnormal clinical and laboratory	4	2019	.13	3	78	.40	p=.0001	3	2946	.18	4	108	.51	p=.0001
139–151 Accidents	3	2103	.14	4	63	.33	p=.0001	4	2845	.18	3	112	.53	p=.0001
053–062 Diseases of the respiratory system								5	1859	.12	5	79	.37	p=.0001
012–018 Viral diseases				5	59	.31	p=.0001							
046–052 Diseases of the circulatory system	5	1549	.10				p=.0049							

[a]Rates are expressed as per 1,000 live births.
AI=American Indians
AN=Alaska Natives

system 59 to 79 (0.31/1,000 to 0.37/1,000) p=.30, between 1995–1999 to 2000–2004, these changes were not statistically significant. It is worth noting that the change in congenital malformations may not have been significant only because of the small numbers, despite that it does approach significance. On the other hand there was a statistically significant decrease among deaths attributed to viral diseases 59 to 19 during the same time period.

Discussion

Previous studies have documented health disparities between AI/AN and Whites in the form of higher infant mortality rates, most notable in the postneonatal time period.[3,15] Our study examined infant mortality rates and cause of death in AI/AN and Whites in 1995–1999 and 2000–2004. Infant mortality rates improved in the neonatal and postneonatal periods in Whites, while no significant improvement was noted among AI/AN. We found that infant mortality disparities persists between AI/AN and Whites, and the greatest disparity was observed in the postneonatal period. This finding confirms previous studies which have shown that AI/AN experience a disproportionate burden of infant mortality in the postneonatal period. From 1995–1999 to 2004–2004, SIDS rates declined significantly within both racial groups; however the proportional discrepancy between AI/AN and Whites remained largely unchanged in the postneonatal periods, and AI/AN infants were 2.7 times more likely to die from this condition than Whites in both time frames.

In examining health disparities in infant mortality between AI/AN and Whites it is important to note the social context in which these disparities occur. Many American Indians reside in health professions shortage areas (HPSAs). According to the Health Resources and Services Administration, AI/AN as defined in section 4(d) of PL 94-437 are automatically designated as population HPSAs. Furthermore, facilities operated by a tribe operated under the Indian Self-Determination act and urban Indian organizations receiving funds under Title V of the Indian Healthcare Improvement act are designated HPSAs.[16]

According to 2010 US Census data AI/AN, experience higher poverty rates, lower median incomes, lower educational attainment, and lower rates of health insurance than other Americans.[17] Inequalities in these socioeconomic factors between AI/AN and Whites contribute towards health disparities between these two communities. At 53.2%, AI/AN experienced the lowest rate of access to prenatal care in the first trimester among all racial groups. On the other hand, 69.5% of Whites reported access to prenatal care during this time frame.[18] In addition, at 14.4%, AI/AN had the highest rate of all races of mothers initiating prenatal care which in the third trimester or receiving no prenatal care.[18] Access to prenatal care is associated with improved infant outcomes through the identification of maternal risk and pregnancy complications at an early stage of pregnancy, and the provision of medical, nutritional, and educational and other interventions such as smoking cessation, intended to reduce the adverse pregnancy outcomes related to these conditions.

The reduction in SIDS-related deaths confirm previous studies that have shown a decrease in this condition over time.[3,19] This decrease may be due to national targeted

interventions such as the *Back to Sleep Campaign*, which promotes public health nurse visits and raises awareness of SIDS risk factors such as: infant exposure to tobacco smoke, prone sleeping position, bed sharing, layered clothing, and maternal alcohol consumption.[20,21] However, while public health professionals should applaud the reduction in SIDS among AI/AN, the disproportionate burden of infant mortality attributed to SIDS and other causes in the postneonatal time period in this population is cause for concern. While sustained public health efforts aimed at reducing SIDS in AI/AN communities may have had an impact on this condition in the postneonatal period, the reduction in post-neonatal SIDS infant mortality rates among AI/AN (RR=0.73) were nearly identical to the reductions among Whites (RR=0.73). These results underscore the need for additional efforts to address disparities.

Additional causes contributing to the disparity in postneonatal mortality in AI/AN included accidents and diseases of the respiratory system during both time intervals where AI/AN were more than twice as likely as Whites to die from either condition. These findings are consistent with other studies which reveal a disproportionate burden in these causes of death in comparison to Whites.[15,3] Accidents and diseases of the respiratory system are to some degree preventable and treatable and indicate potential areas for future public health interventions. In addition, congenital malformations represented a source of disparity of postneonatal infant mortality where the disparity between AI/AN and Whites increased from 1.2 to 1.7 times between 1995–1999 and 2000–2004 (p=.01). This finding is of particular interest and could either be related to a higher incidence of congenital anomalies in the AI/AN population, due to environmental exposures (including tobacco, alcohol, and other illicit drug exposures) or genetic predisposition. We cannot rule out the relevance of early diagnoses of chromosomal abnormalities during pregnancy and access to elective termination to be another factor associated with variation in early neonatal death from congenital abnormalities. This may be most consistent with the lack of access and utilization of prenatal care services in the AI/AN populations.

The increased number of postneonatal deaths from congenital malformations and chromosomal abnormalities among AI/AN between 1995–1999 and 2000–2004 should be recognized. Congenital anomalies have been identified as the second leading cause of infant mortality among AI/AN; however, limited data exist concerning the morbidity of such malformations. The most recent published study that we could identify used data from the national hospital discharge database of the Indian Health Service 1980–1988. Morbidity rates of four easily identifiable midline malformations among liveborn infants estimated rates per 10,000 births were neural tube defects (8.09); oral clefts (29.03); abdominal wall defects (2.99); and tracheoesophageal fistula (1.86).[22] The lapse in time since this study suggests the need for further examination of the causality of the congenital malformations in this population. Furthermore, potential benefits associated with folic acid supplementation during pregnancy or the lack thereof should be tested.

The heterogeneity of AI/AN communities in the form of 566 federally recognized tribes, in addition to state and non-recognized tribes, urban AI/AN who make up the majority of the AI/AN population, and immigrant AI/AN communities, underscores the importance of integrated local public health efforts that consider environmental and

socio-economic factors that in addition to SIDS, may perpetuate higher postneonatal mortality rates from accidents and diseases. For instance, according to 2007 data, at 36.4%, AI/AN maintained a statistically significant higher smoking prevalence than all other racial and ethnic groups. This finding is also manifested in a higher pre-pregnancy smoking prevalence among AI/AN in comparison to other races, where pre-pregnancy smoking prevalence is defined "as the percentage of women who recently delivered a live birth who self-reported smoking during the 3 months before pregnancy."[23[p.A121]] With a pre-pregnancy smoking prevalence that appears to exceed 40%, AI/AN had the highest pre-pregnancy smoking prevalence among all races, 2004–2008, according to data from the Pregnancy Risk Assessment Monitoring System.[23]

Second-hand cigarette smoke is associated with SIDS and diseases of the respiratory system.[24] Other studies have identified prenatal alcohol use as a risk factor for postneonatal infant mortality among AI/AN.[10,19] While cigarette smoking and alcohol use prevalence varies by geographic region, continuing efforts to these risk factors in communities with high postneonatal infant mortality rates and high prevalence of tobacco and alcohol use remains of paramount importance.

There are several limitations to this study. 1. The replacement of ICD9 groups by ICD 10 results in discontinuous infant mortality trend and patterns. For instance, in the employment of ICD 10, there is a nearly 4% increase in SIDS-related deaths in comparison to when ICD-9 was used. ICD-9 treated SIDS as an ill-defined condition and did not include SIDS in the presence of other defined conditions. Under ICD-10 SIDS is well-defined and may be selected as the underlying cause of death in the presence of other causes of death listed on the death certificate.[13] 2. The data employed in the study were at the time of analysis the most recent available data. Given the time lag between analysis and availability of most recent data, the findings from this study may not reflect the present state of infant mortality rates in AI/AN and Whites. 3. While prior studies have documented racial misclassification of AI/AN on death certificates which has resulted in underreporting of AI/AN infant mortality rates, our use of birth-linked data sets minimized the issue of racial misclassification; however, if the mother is racially misclassified so is the child.

One of the five overarching goals of *Healthy People 2020* calls for the "achievement of health equity, elimination of disparities, and improvement of the health of all groups."[25[p.1]] This goal is endorsed by the National Prevention Strategy, a provision in the Patient Affordable Care Act which outlines four strategic directions that synergistically provide a foundation for improving the nation's health and includes the elimination of health disparities.[25,26] Our finding that AI/AN continue to experience health disparities in the form higher infant mortality rates in comparison to Whites with a disproportionate burden of deaths in the postneonatal period underscores the need for further research and subsequent development of targeted interventions.

Notes

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