
Decline in Infant Mortality of Alaskan Yupik Eskimos from 1960 to 1980

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Synopsis.....

A 1960-62 study of southwestern Alaskan Eskimos documented an infant mortality rate—102.6

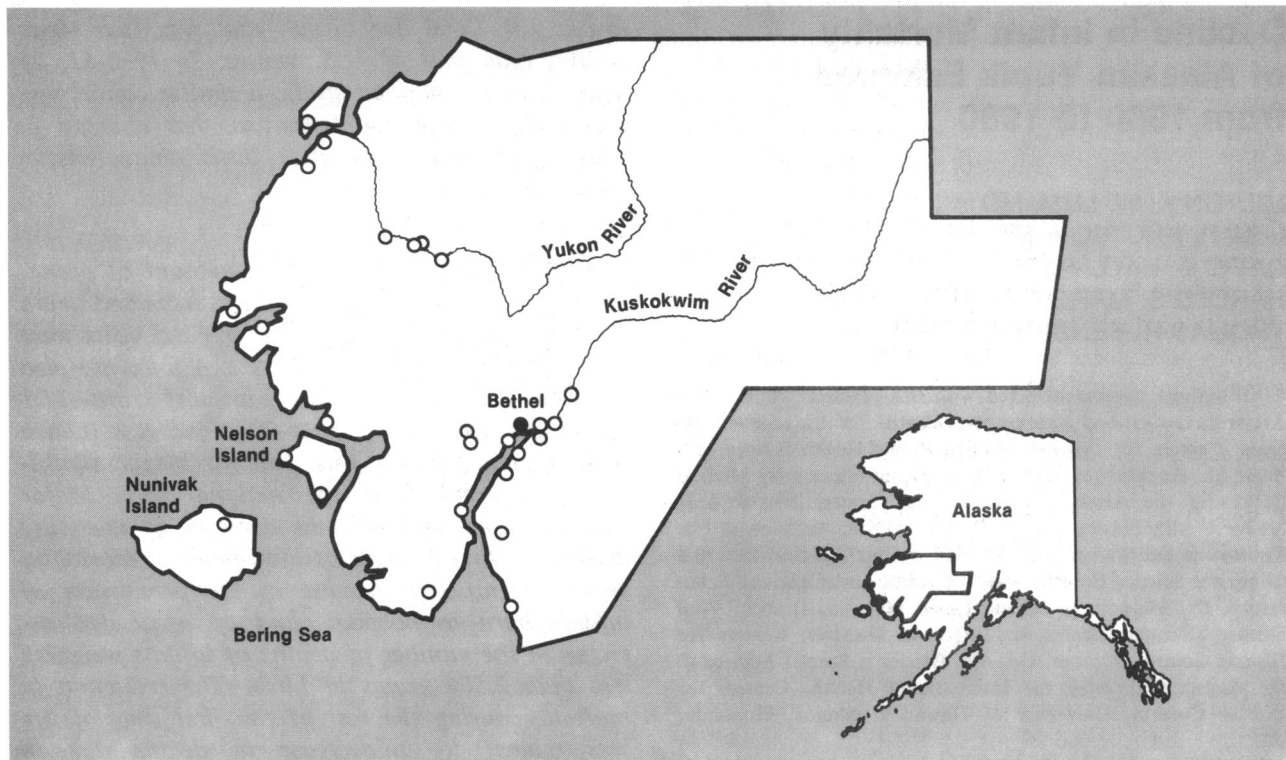
deaths per 1,000 live births—that was four times greater than that of U.S. whites. In 1980-81, 20 years after the original study, a similar cohort was identified in this population so that changes in infant mortality and other birth characteristics could be examined.

Average birth weight and the amount of prenatal care received by the mothers increased from 1960 to 1980. Birth weight and prenatal visits were positively correlated. Results of the followup also revealed a 1980-81 infant mortality rate—17.1 deaths per 1,000 live births—that was less than a fifth of the 1960-62 rate and no longer significantly different from the national rate. Major changes associated with the decrease in mortality during the first 28 days of life (neonatal mortality) were a significant increase in the proportion of infants born in hospitals and an associated decrease in the number of deaths of infants weighing less than 2,500 grams at birth. The reduction in mortality during the rest of the first year of life was related to a decrease in deaths due to infectious diseases, particularly measles and pertussis. Changes in infant mortality reflect the increased availability of health care in this region, improved immunization programs, and the establishment of the Bethel Prematernal Home in Bethel, AK.

INFANT MORTALITY IN INDIGENOUS populations of North America has been shown to be higher than that of the general U.S. population (1). A study carried out in 1960-62 among Eskimos living in southwestern Alaska documented an infant mortality rate four times greater than that of U.S. whites (2). Reviews of infant births and deaths in this population during the early and mid-1970s indicated that the infant mortality rates had been reduced from the high levels of 1960-62. By the early 1970s neonatal mortality was less than one-half, and postneonatal mortality was less than one-fifth, of their earlier levels. Twenty years after the original study, in 1980-81, we conducted a followup study to evaluate infant mortality among Eskimo residents of the same area. This paper compares these cohorts with respect to infant mortality and factors related to pregnancy and delivery.

Background

Yupik-speaking Eskimos live in approximately 50 small villages located within the 94,000 square-mile alluvial plain of the Yukon and Kuskokwim Rivers of southwestern Alaska (see map). In 1960, the lifestyle in these villages was largely traditional, with a subsistence economy based on hunting and fishing. Living conditions in the home were generally crowded (3). Travel by dog sled in winter and skiff in summer was routine. The local delivery of health care for the people was limited to acute care by teachers at the village schools, with emergency air evacuation to the Public Health Service Alaska Native Hospital in the regional hub of Bethel. The practice of midwifery was not uniform; traditionally women gave birth in the village, with family members attending to the mother and her new infant (2).



¹Circles indicate the 27 Eskimo villages in the 1960-62 study.

By the 1980s, many forms of modernization have come to these villages. Widespread use of snowmachines, planes, and outboard motors has greatly increased the ease of travel. The health care delivery system has become much more comprehensive. Resident community health aides in each village provide primary care, with routine daily radio or telephone support from hospital staff in Bethel and periodic visits from health service personnel. Referrals are made to regional hospitals in Bethel and Anchorage. The lifestyle in many villages, however, still includes traditional elements, such as use of the Yupik language and reliance on subsistence hunting and fishing for food.

Materials and Methods

Study of 1960-62. The data for this period were originally gathered as part of an infant morbidity and mortality study conducted in 27 Eskimo villages, which were selected because they had participated in a tuberculosis prophylaxis program conducted by the same research group. The methods used to gather these data have been described in detail elsewhere (3). Initiated in 1960, the study was designed to provide information on birth and

mortality rates, infant growth patterns, and illness during the first year of life. The study villages had a combined population in 1960 of just over 6,000. In each village a resident Eskimo aide was recruited to keep a record of all pregnancies and to determine the birth weights of newborns within 24 hours of delivery. During quarterly visits to the villages, research nurses gathered data on the health and nutrition of women in the third trimester of pregnancy. They also collected information on the delivery of each newborn and the growth, nutrition, and illnesses of each child. Deaths of infants in the study were investigated through interviews with the parents and reviews of hospital and radio medical traffic records. The recruitment period extended for 2 years.

Study of 1980-81. The data from this period were collected with the goal of providing information on pregnancy, delivery, and infant mortality comparable with that from the original 1960-62 study period. As part of an Indian Health Service's maternal and child health program instituted in this region in 1973, pregnant women were monitored by village health aides, physicians, and nurse practitioners. Prenatal visits were carefully monitored and documented. Following delivery, the

infants were monitored for growth, development, and vaccinations through the first year of life. The study data for all births to Alaska Natives in this region in 1980 and 1981 were abstracted from these maternal and child health records. Death certificates from the State of Alaska for 1980-82 were reviewed to identify all deaths of Alaska Natives under 1 year of age and born in 1980-81. Information on infant deaths was also obtained from the Indian Health Service's maternal and child health program office, which reviews all reports of death in Alaska Native infants.

As stated earlier, these 1980-81 data were obtained on all births to Native residents of the Bethel Service Unit; the original study was restricted to 27 Yupik Eskimo villages within this region. Between 1960 and 1980 many changes had taken place in the location or organization of these villages. A total of 34 villages, including all of the original 27, are included in the analyses of the 1980-81 data. The combined 1980 population of these 34 villages was just over 9,500 persons.

Definitions. Infants with known birth weights were divided into those who weighed less than 2,500 grams at birth (low birth weight) and those who weighed 2,500 gram or more at birth (normal birth weight). Infant deaths were divided into those occurring during the first 28 days of life, or neonatal period, and those occurring from 29 days through 11 months of age, or the postneonatal period. Cause of death was classified according to the International Classification of Diseases, Ninth Revision (4).

Statistical methods. Birth and infant mortality rates for 1960-62 and 1980-81 were compared with the corresponding national rates, using a test for the significance of the ratio of a Poisson variable to its expectation (5). Comparisons with respect to ordered variables such as birth weight and maternal gravidity were made using Student's *t*-test for independent samples. A test for linear trends in proportions was used to assess the relation of national birth weights to the study data. The Wilcoxon rank sum test was used to examine the number of prenatal visits the mothers received. Comparisons of proportions were made using Fisher's exact test and chi-square test as appropriate. When adjustments for additional factors were necessary, the Mantel-Haenszel test for association was employed. One-sided probability values are reported for Fisher's exact test results. Other reported probability values are two-sided.

Results

Vital statistics. In the study region, 643 live births were reported during the 1960-62 data collection period, for a crude annual birth rate of 52.8 births per 1,000 population. The infant mortality rate was 102.6 deaths per 1,000 live births, with a neonatal mortality rate of 46.7 deaths per 1,000 live births (30 neonatal deaths) and a postneonatal mortality rate of 56.0 deaths per 1,000 live births (36 postneonatal deaths). All these birth and mortality rates are significantly greater ($P < 0.001$) than the 1960 rates for all races in the United States (table 1) (6).

Table 1. Infant mortality rates per 1,000 live births¹ for Yupik Eskimos and the United States

Group	1960-62	1970-72	1975-77	1980-81
Neonatal (0-28 days):				
Yupik Eskimo	46.7	20.5	10.5	12.0
United States	18.4	14.3	10.8	8.1
Postneonatal (29 days-11 months):				
Yupik Eskimo	56.0	9.7	13.4	5.1
United States	7.0	4.9	4.3	4.0
Overall infant mortality:				
Yupik Eskimo	102.6	31.2	23.9	17.1
United States	25.4	19.2	15.1	12.1

¹ Rates for Yupik Eskimos in 1960-62 and 1980-81 apply to the selected study villages. Rates for Yupik Eskimos during the other periods were obtained from the files of the Alaska Department of Health and Social Services and pertain to all Eskimo villages in the Yukon-Kuskokwim Delta region.

During the 1980-81 period, 584 births were reported for the 34 Yupik villages studied, for an annual birth rate of 30.6 births per 1,000 population. Although the crude birth rate had decreased substantially by the 1980-81 period, it was still significantly ($P < 0.001$) greater than the U.S. rate of 15.8 births per 1,000 population (7). The infant mortality rate had declined to 17.1 deaths per 1,000 live births, a rate less than a fifth of that in 1960-62. The 1980-81 infant mortality rate did not differ significantly from that for the United States, which had also decreased since 1960-62. The decrease in the neonatal mortality rate in the study area was more than 3 times the decrease in the national rates, and the decrease in the postneonatal mortality rate was 17 times the national decrease.

This decrease in Eskimo infant mortality from the 1960-62 level to the 1980-81 level is part of a trend documented for the 20-year period (table 1). Much of the decrease, particularly in postneonatal mortality, appears to have occurred by 1970.

Table 2. Characteristics of pregnancy and delivery in Yukon-Kuskokwim Delta Eskimos

Characteristics	1960-62	1980-81
Number of live births	643	584
Maternal characteristics:		
Average number of pregnancies ...	6.4	3.5
Proportion primigravid	0.097	0.241
Average age (years)	29.1	26.0
Health care:		
Proportion hospital deliveries	0.589	0.976
Proportion with prenatal care	0.776	0.969
Median number of prenatal visits...	2	7
Birth weight:		
Average birth weight (grams)	3,257	3,495
Proportion low birth weight	0.088	0.065

Table 3. Postneonatal deaths by cause for Yukon-Kuskokwim Delta Eskimos

Cause of death	ICD code ¹	1960-62		1980-81	
		Number	Rate ²	Number	Rate
Measles-pertussis	055, 033	9	14.0	0	...
Respiratory infections....	465, 485, 487				
Associated with measles-pertussis.....		7	10.9	0	...
Other		11	17.1	1	1.7
Gastroenteritis	009.2	5	7.8	0	...
Central nervous system ..	320	4	6.2	0	...
Sudden infant death syndrome.....	798.0	0	...	1	1.7
Reye's syndrome.....	331.8	0	...	1	1.7
Total		36	56.0	3	5.1

¹ International Classification of Diseases codes.

² Rate per 1,000 live births.

Pregnancy and delivery. The mean gravidity decreased significantly from 1960-62 to 1980-81 ($t=16.38$, $df=1,211$, $P < 0.001$), with a corresponding increase in the proportion of primigravid women ($\chi^2=44.33$, $df=1$, $P < 0.001$) and a corresponding decrease in the average age of the women giving birth ($P < 0.001$) (table 2). Changes in gravidity are still significant after adjustment for maternal age.

During 1960-62, 41.1 percent of the liveborn infants (264 of 643) were delivered in the village or other nonhospital setting. By 1980-81 this proportion had declined to 8.4 percent (49 of 584), a highly significant decrease ($\chi^2=175.77$, $df=1$, $P < 0.001$). The amount of prenatal care received

by the women in this region has greatly increased since 1960-62 (table 2); there was a significant change both in the proportion of women receiving no care ($\chi^2=97.93$, $df=1$, $P < 0.001$) and in the amount of care received (Wilcoxon rank sum $Z=18.50$, $P < 0.001$).

Birth weight. Between the two periods, the average birth weight of the infants in this region increased significantly, from 3,257 grams to 3,495 grams ($t = 6.89$, $df = 1151$, $P < 0.001$). The 1960-62 birth weights did not differ significantly from those for all races in the United States (8) ($Z = 1.46$, $P = 0.145$), but the 1980-81 newborns were significantly heavier than would be expected based on national birth weights (9) ($Z = 5.99$, $P < 0.001$).

The observed change in birth weights from 1960-62 to 1980-81 was related to place of delivery. The average birth weight of infants born in the hospital in 1960-62 was somewhat greater than the average for those born outside hospitals ($t = 1.95$, $df = 583$, $P = 0.051$); in 1980-81 this difference was greatly increased ($t = 4.11$, $df = 559$, $P < 0.001$).

Infant mortality-neonatal deaths. Twenty-two of the 30 neonatal deaths in 1960-62 were of low-birth-weight infants, giving a relative risk (RR) of neonatal death in infants with low birth weights, compared with infants weighing 2,500 grams or more, of 46.5 ($P < 0.001$). Place of delivery was also a significant risk factor, with a relative risk for nonhospital to hospital births of 9.7 ($P = 0.002$).

In general, the same risk factors operated during the 1980-81 period. Infants with low birth weights remained at increased risk of neonatal death, ($RR = 101.63$, $P < 0.001$), as six of the seven neonatal deaths were of low-birth-weight infants. The relative risk for nonhospital to hospital births, 4.5, was no longer significant ($P = 0.110$).

The proportion of infants dying during the neonatal period declined significantly ($\chi^2 = 11.49$, $df = 1$, $P < 0.001$) from 4.7 percent (30 of 643) in 1960-62 to 1.2 percent (7 of 584) in 1980-81.

Infant mortality-postneonatal deaths. The postneonatal death rate declined from 56.0 deaths per 1,000 live births in 1960-62 to 5.1 deaths per 1,000 live births in 1980-81 (table 1). The percentage of postneonatal deaths in infants who had survived the neonatal period dropped significantly ($\chi^2 = 50.5$, $df = 1$, $P < 0.001$) from 5.9 percent

(36 of 613) in 1960–62 to 0.5 percent (3 of 577) in 1980–81. Much of this improvement in postneonatal survival was attributable to the decrease in the number of deaths associated with measles or pertussis (table 3). During 1960–62, measles or pertussis was listed as the primary or secondary cause of death for 16 deaths in the postneonatal period; in contrast, none of the postneonatal deaths in 1980–81 was associated with these infections. The other major causes of postneonatal death in 1960–62 had also declined dramatically by 1980–81.

The important risk factors associated with neonatal death were not significantly associated with postneonatal death. During 1960–62, neither nonhospital delivery nor low birth weight resulted in a significant relative risk of postneonatal death among those at risk (place of delivery: $RR = 0.66$, $\chi^2 = 0.89$, $df = 1$, $P = 0.35$; birth weight: $RR = 0.69$, $\chi^2 = 0.14$, $df = 1$, $P = 0.71$). The three postneonatal deaths during 1980–81 followed a similar pattern.

Discussion

An overriding concern in studies of this sort is the validity of comparisons and the resultant inferences. In our study the monitoring and reporting systems for 1960–62 and 1980–81 closely parallel each other. For both cohorts, designated village residents were responsible for monitoring prematernal, prenatal, natal, and infant health. Nurses were responsible for periodic village visits to monitor maternal and child health. Physician care was provided by medical staff of the Indian Health Service. The geographic isolation of these villages and the comprehensive health care delivery system make it possible to ensure unusually complete and reliable reporting and documentation by limiting travel and migration. The size of these villages makes it possible for the resident monitor to conduct comprehensive surveillance.

Elevated rates of both neonatal and postneonatal mortality contributed to the high infant mortality rates seen in the Yupik Eskimos in 1960–62, rates significantly higher than the overall U.S. rates. By 1980–81, however, the combined rate for this group had declined to less than a fifth of its previous level and was no longer significantly higher than the national rate. Furthermore, the 1980–81 infant mortality rates for this group exhibit the expected pattern of a neonatal mortality rate substantially greater than the postneonatal rate. Thus, a population previously having a

significantly increased infant mortality rate with a large postneonatal component has improved until it is now comparable with the national norm.

The trend toward lower infant mortality rates is clear. In neonatal mortality this population began with a rate more than twice the national rate and improved to a level comparable with the national one by 1975, even as the national neonatal mortality rate decreased by a third. In postneonatal mortality this population in 1960–62 had a rate eight times the national rate; it improved to a level comparable with the national rate by 1970.

The most significant factor contributing to neonatal mortality in 1960–62 was a birth weight of less than 2,500 grams. Low birth weight is a known risk factor for neonatal death (10), and various intervention strategies have been tried to reduce the number of infants with low birth weights. Provision of prenatal care was increased in an attempt to reduce the proportion of infants with low birth weights and to improve neonatal survival. Both the average amount of care received and the average birth weight increased over the 20-year period, the birth weight to a level significantly greater than the national average. Survival improved in low-birth-weight infants and accounted for part of the drop in neonatal mortality.

During the 1960–62 period, infants born in the villages had a greater risk of dying during the neonatal period than infants born in the hospital. Many mothers recognized the inherent problems of delivering their children in the villages, yet they were forced to remain there because of financial and social constraints. In 1965, Native leaders and the Alaska Area Native Health Service, part of the Indian Health Service, established the Bethel Prematernal Home to provide quarters for pregnant women awaiting delivery. Its presence encouraged women to come to Bethel and deliver their babies in the hospital. By 1980 more than 90 percent of the deliveries in this region took place in the hospital. The Indian Health Service's maternal and child health program, initiated in 1973, provides education and counseling that encourage prenatal visits and emphasize the importance of the availability of proper medical support at delivery. Infants born outside the hospital in 1980–81 remained at increased risk of neonatal death, but this risk had also declined from its 1960–62 level, possibly because of improved health care at the village level and easier access to Bethel for medical care.

The Community Health Aide Program was formalized in 1968 to recruit and train local

individuals to provide primary health care in their own villages, improving access to medical care (11). The expanded physician staff at the hospital in Bethel was able to supervise the health aides, usually by radio, allowing more patients to be diagnosed, treated, or referred to the hospital in the early stages of disease.

In 1960-62, the postneonatal mortality rate for the study group was significantly above the national rate. Measles and pertussis contributed to the large number of postneonatal deaths. The Alaska Area Native Health Service and the Alaska Department of Health and Social Services made a concerted effort to improve the immunization rates of the Alaska Native children, and by the end of 1963, 90 percent of the children of the Yukon-Kuskokwim Delta had been immunized. In 1980-81, there were no deaths associated with measles or pertussis, compared with 16 deaths recorded in 1960-62.

A decrease was also observed in postneonatal mortality from other respiratory infections, dropping from 17.1 deaths to 1.7 deaths per 1,000 live births. Studies of Canadian Eskimos have shown high mortality rates resulting from respiratory infections. In those studies, factors such as crowding, poor nutrition, and limited access to health care facilities were found to be related to the high mortality (12,13). We observed a temporal association between high infant mortality and limited access to health care facilities. There was also crowding and poor nutrition for the Alaskan Eskimo children in 1960-62, and these may have contributed to their high mortality rates (3,14).

Since the 1960-62 study, dramatic reductions in infant mortality rates have been shown for the Yupik Eskimos. Much of this improvement had been noted by preliminary assessments of infant mortality in this region in the early and mid-1970s. The reductions then seen were sustained through 1980-81. Improvements in the survival rates of infants with birth weights of less than 2,500 grams and a reduction in the number of deaths due to infectious diseases were the major reasons for this decline. Changes in the lifestyles and living conditions of these people probably contributed to this decline, although these changes were not explored in this study. As with any study of this sort, it is impossible to determine how much of the observed change is attributable to changes in health services, to changes in living conditions, or an interaction of the two. The Bethel Prematernal Home, the Indian Health Service's maternal and child health

program, and the Community Health Aide Program illustrate the adaptations made by the health care delivery system in an attempt to eliminate the negative effects of geographic isolation on this population.

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