Relation of Prenatal Care to Birth Weights, Major Malformations, and Newborn Deaths of American Indians

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PRENATAL NUTRITION has been reported to be associated with birth weight (*1, 2*) and prematurity (*3*). A review of several studies on prematurity (*4*) included reports of associations of high prematurity and neonatal mortality rates with little or no prenatal care. In a study of birth weights of Negro infants (*5*), the highest mean birth weight, the longest gestation periods, and the lowest percentage of low birth weight infants occurred among mothers with private prenatal care, followed by mothers with clinic care and no care, in that order. A study of births in Maryland (*6*) showed fewer low birth weight infants among mothers whose care began in the first trimester than among those with later care or no care. Schwartz (*7*) has stressed the importance of gestational age in analyzing prenatal care data and pointed out the number of biases which may influence results. He concluded that, among women in gestation week 37 and later, prenatal care is significantly associated with birth prematurity and neonatal mortality.

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As part of a 5-year study on congenital malformations in American Indian infants, data were analyzed to determine if prenatal care is associated with birth weights, newborn deaths, and major malformations in an American Indian population.

Methodology

Copies of the records of all births in the Public Health Service's Indian hospitals from July 1, 1964, through June 30, 1969, were sent to the Division of Indian Health and to the Human Genetics Branch of the National Institute of Dental Research. Each infant's newborn and inpatient records contained the newborn's medical examination, hospital course, tribal affiliation, and mother's prenatal history. Approximately 40 variables were coded from the hospital records, and a computer data base was constructed from the records of the 44,269 reported infants.

For the present analyses, 749 infants of multiple births (373 twin births and one triplet birth) were excluded. Of the 43,520 single births, 111 stillbirths were not included because newborn records were not routinely completed for stillbirths, and this relatively small portion of the total number of stillbirths might have been unrepresentative of the total. From the population of 43,409 liveborn, single-birth infants, 4,827 were omitted because information on prenatal care or birth weight, or both, was not available on the newborn records. The population analyzed in this report consisted of 38,582 liveborn, single-birth infants for whom birth weight and the presence or absence of prenatal care were known.

Prenatal care was categorized as the time of the mother's first prenatal care visit—first, second, or third trimesters, no care, or some care initiated at an unknown time.

Considerable variation in mean birth weight between the different tribal groups has been shown previously, and the significance of this in relation to arbitrary definitions of prematurity by weight has been discussed (*8*). Because of the large number of different tribes in our study, treatment of each tribe separately is unwieldly. Therefore, to partially control for intertribal variations we sorted the tribes into eight groups on the basis of linguistic affiliations—Athapascan, Aleut-Eskimo, Algonquin, Iroquoi-Muskhogean, Hokan-Siouan, and Uto-Aztecan. These groups comprised 95 percent of the total population, with other and non-Indian categories making up the remaining 5 percent.

Birth weights were distributed for each prenatal care group, and weight statistics were calculated. Low birth weight infants were not excluded from the data, but the percentage of such infants was determined for each prenatal care group. Low birth weight was defined two ways: (*a*) as any infant weighing less than 88 ounces and (*b*) as those whose weights were more than 1.65 standard deviations below the mean for their linguistic group—to control for intertribal variations. No attempt was made to separate infants with short gestations from those with retarded fetal growth since, in most cases, information about length of gestation was vague or missing.

The percentages of newborn deaths and infants with major malformations were calculated for each prenatal care group. Since the only available information on death was on the newborn record, newborn deaths in this report include all infants who died after birth but before hospital discharge. Most of these deaths occurred less than 28 days after birth. Definition of what constitutes a major malformation is at best arbitrary. We followed criteria used in previous population studies (*9–12*) which define a major malformation essentially as a defect which, if uncorrected, will shorten lifespan or limit reproduction.

Newborn records were completed for infants born outside the hospitals but admitted within 48 hours, and they were included in the samples. The potential biases in this group have been considered in the analyses.

Prenatal care is only one of many interrelated factors which may influence pregnancy outcome. Information was available in the newborn record on a number of potentially important epidemiologic variables. By using correlation and multiple regression analysis (*13*), we identified genetic and environmental variables which showed significant associations with birth weight, major malformation, and newborn death. After the effects of these significant variables were accounted for, we determined the relationship of prenatal care to the pregnancy outcome variables.

The analytical procedure was as follows:

1. Simple correlation coefficients were calculated between all epidemiologic variables and the variables related to pregnancy outcome.

2. For each pregnancy outcome variable, the epidemiologic variables (except prenatal care) that were significant at the 5 percent level or higher were fitted stepwise in a multiple regression equation. (The first step in the stepwise procedure is to choose the single epidemiologic variable which is the best predictor of the pregnancy outcome variable under consideration. In the second step, the variable which provides the best prediction in conjunction with the first is added.) In this fashion, variables were added step by step until no other variable made a significant improvement in the prediction equation.

3. After all other significant epidemiologic variables were in the equation, prenatal care was entered so that its effect, independent of the other variables, could be estimated. From the multiple regression analysis we obtained partial regression and correlation coefficients between prenatal care and pregnancy outcome variables.

The foregoing procedure allows tests of the sig-

Table 1. Mean birth weights and percentages of low birth weights, newborn deaths, and major malformations, by prenatal care for live single births, all tribes

Prenatal care	Number births [1]	Mean birth weights (ounces)	Standard error	Percentages of— Low birth weights [2]	Major malformations	Newborn deaths
No care	7,094	111.83	0.248	8.3 (11.4)	2.38	1.8
Third trimester	9,448	116.96	0.187	3.7 (5.3)	2.03	0.5
Second trimester	8,714	117.69	0.209	4.3 (5.7)	1.87	0.8
First trimester	4,819	118.08	0.272	4.3 (5.8)	1.68	0.6
Some care (first visit unrecorded)	8,507	117.25	0.209	5.1 (6.6)	2.12	1.1

[1] Number with recorded birth weight.
[2] 1.65 or more standard deviations below the mean of infants' linguistic group. Numbers in parentheses are percentages of infants weighing less than 88 oz.

nificance of prenatal care and estimation of the direction and magnitude of its association with each of the variables relating to pregnancy outcome. It is equivalent to holding constant all the other epidemiologic variables while studying the effects of prenatal care. Further details of partial correlation and stepwise multiple regression procedures appear in various texts (*13, 14*).

Results

Table 1 summarizes the data for birth weights, major malformations, low birth weights, and newborn deaths. The mean birth weight was lower in the group with no prenatal care than in any other care category. The percentages of low birth weight infants also reflect this difference. Although the data in this table suggest that birth weight decreases with later initiation of prenatal care, the decreases are not great. In the no-care group, there was a two- to threefold increase in newborn deaths and a slight increase in major malformations.

Table 2 shows simple correlation coefficients between the epidemiologic variables under consideration and the pregnancy outcome variables. Linguistic group is also listed in this table for completeness, although correlation coefficients are not applicable. Birth weights, major malformations, and newborn deaths show significant differences between language groups when tested by analysis of variance. Consequently, these differences are controlled by incorporating language groups in the multiple regression analysis by using dummy variables (*10*).

Table 2. Correlation coefficients, significant at 5 percent level, between variables relating to pregnancy outcome and certain epidemiologic variables

Epidemiologic variable [1]	Birth weights (Y_1)	Major malformations (Y_2)	Newborn deaths (Y_3)
Sex, X_1	0.09	0.02	0.01
Maternal age, X_2	.05	[2].02	[2].01
Paternal age, X_3	.08	......	......
Number of previous pregnancies, X_4	.11	.02	.02
Prenatal care, X_5	.12	[2] −.01	−.05
Maternal serologic tests for syphilis, X_6	[2] −.02	......	......
Nonhospital birth, X_7	−.05	.01	[2].01
Residence, X_8	[2].01	......	......
Illegitimacy, X_9	−.08	......	[2].02
Child's degree of Indian blood, X_{10}	−.08	[2].01	......
Low birth weight, X_{11}	......	.04	.28
Linguistic group[3]	......	......	......

[1] The variables were scored as follows: Linguistic group (7 dummy variables, each with a value of 0 or 1, were constructed by a procedure outlined by Draper (*14*): sex of infant (0 = female, 1 = male); maternal age; paternal age; number of previous pregnancies; maternal tests for syphilis (0 = negative, 1 = positive); hospital birth (0 = in hospital, 1 = outside hospital); residence (0 = on reservation, 1 = off reservation); illegitimacy (0 = legitimate, 1 = illegitimate); degree of Indian blood (recorded in eights, 0 = non-Indian, . . . , 8 = full blood); and prenatal care (0 = no care, 1 = some care).
[2] Indicates variables which become nonsignificant in stepwise multiple regression analysis.
[3] Correlation is not applicable. Group means are significantly different at $P < .05$ by analysis of variance.

Table 2 also shows those variables which are no longer significant when considered jointly with the other epidemiologic variables. Neither maternal tests for syphilis nor residence has a significant association with birth weight independent of the other epidemiologic variables. In the case of malformations, maternal age, prenatal care, and degree of Indian blood lose statistical significance when considered jointly with the other variables. Similarly, maternal age, nonhospital birth, and illegitimacy proved to have no independent association with newborn deaths.

The following are partial correlations for prenatal care with birth weights, major malformations, and newborn deaths after the effects of the other (epidemiologic) variables obtained from stepwise multiple regression analysis are accounted for. There remains a highly significant association of prenatal care with birth weights and newborn deaths but not with malformations.

Variables	*Partial correlation*	*P*
Birth weights	0.100	< 0.001
Major malformations ...	— .003	([1])
Newborn deaths	— .026	.001

[1] Not significant.

The regression (prediction) equation derived for birth weight is
Y_1 (birth weight) $= 114.155 + 1.153\ X_4 + 3.541\ X_1 - 0.251\ X_2 - 1.320\ X_9 - 6.670\ X_7 - 0.020\ X_3 - 0.221\ X_{10} + 4.909\ X_5$ (prenatal care). The variables are numbered as in table 2 and appear in the regression equation in the order determined by the stepwise procedure. Adjustment for language groups is included in the constant. For newborn death the regression equation is
$Y_3 = 0.00474 + 0.1166\ X_{11} + 0.0035\ X_1 + 0.0004\ X_4 - 0.0066\ X_5$.

If we substitute the means for low birth weight, sex, and number of previous pregnancies, this equation predicts a newborn death rate of 1.54 percent among mothers with no prenatal care and 0.88 percent for mothers who received care.

Discussion

Although the data presented here are highly suggestive, they do not prove conclusively that prenatal care per se is a direct cause of increased birth weight and reduced mortality. We have included a number of variables in an attempt to more clearly define the role of prenatal care. These variables, however, are certainly imperfect measures of important influences on pregnancy outcome which are likely to be confounded with prenatal care. Such factors as general nutrition and socioeconomic level could not be precisely documented in this study and hence are not completely controlled. Women who seek early prenatal care may have a higher level of education and living standards, better general health, and better nutrition. These factors alone could have important effects on pregnancy outcome. For example, it has been suggested that the nutritional state of the mother before conception may influence the outcome of pregnancy (*15*). A study of social and economic factors affecting the incidence of premature births (*16*) revealed a tendency for a woman's inadequate prenatal diet to be associated with the domestic inefficiency of her mother. Other studies have demonstrated a relationship between socioeconomic factors and birth weight and prematurity (*17, 18*).

Proximity to hospitals (in many cases, tribal population centers) is also likely to be associated with higher living standards. A previous report on the Papago (*19*) showed that the average rate of use of health clinics (for well baby visits in the first year of life) fell proportionally and significantly as the travel time to and from the hospital increased. This situation probably exists for many tribes and could partially account for the effects we observed.

After we corrected for a number of pertinent genetic and environmental factors, significant associations remained between prenatal care and birth weight and infant mortality in American Indians. Lack of prenatal care is associated with a decrease of roughly 4 percent in birth weights and an increase of 40 percent in newborn deaths. That this effect is almost as large as that observed before correction (table 1) suggests that at least a portion is the direct result of prenatal care.

The higher percentage of deaths in the group with no care seems especially worthy of further study. Perhaps a significant decrease in mortality could be effected relatively easily in this group.

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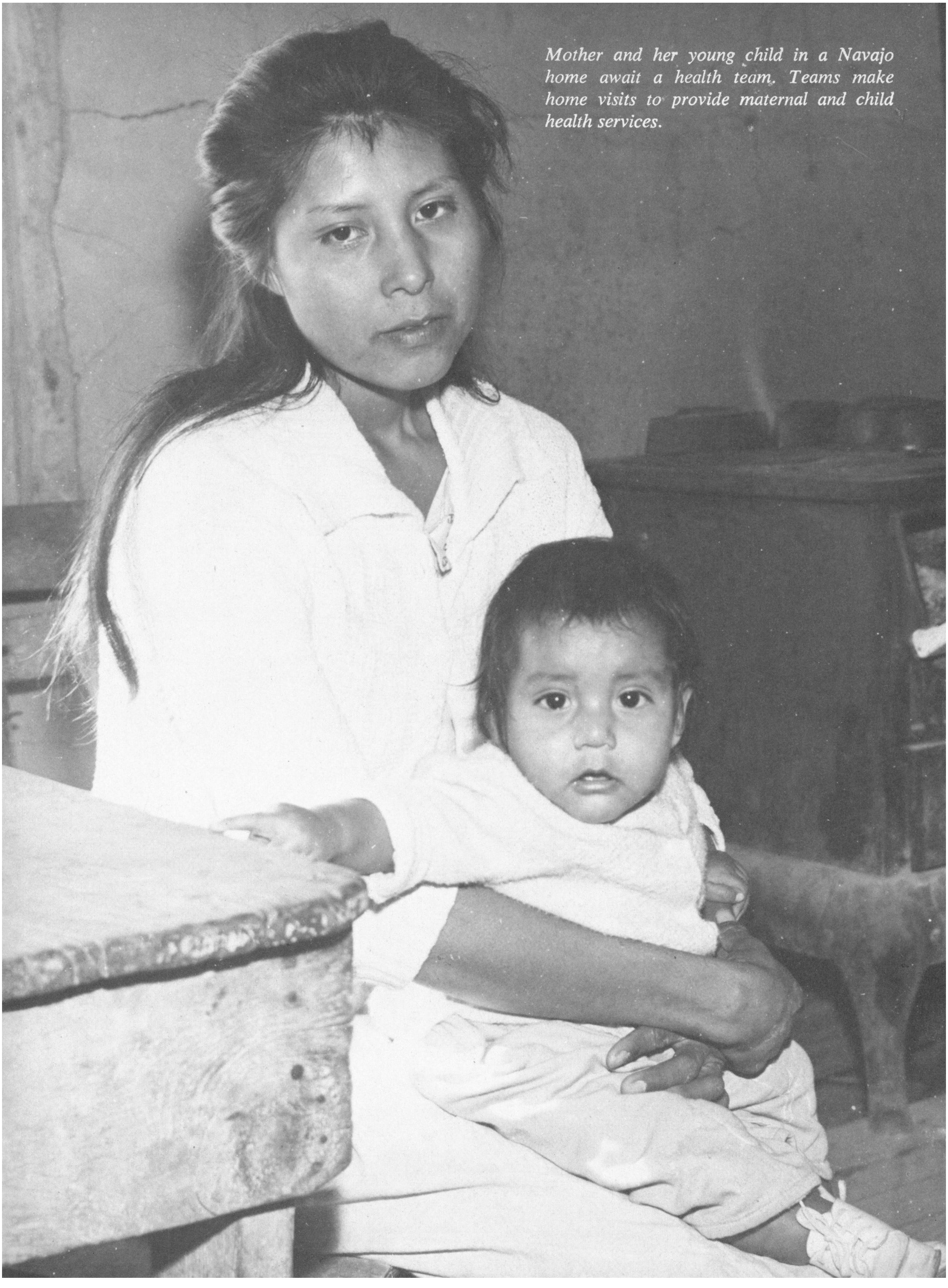
Data from a study of births in the Public Health Service's Indian hospitals from July 1, 1964, through June 30, 1969, were analyzed to determine the relationship of prenatal care to birth weights, newborn deaths (after birth but before hospital discharge), and major malformations of American Indians. The population of newborns in this analysis consisted of 38,582 liveborn single-birth infants whose records contained information on the presence or absence of prenatal care.

The infants born to mothers who did not receive prenatal care had a mean birth weigrt several ounces lower than those whose mothers did receive prenatal care. Mothers with no prenatal care had a higher percentage of low birth weight (less than 88 ounces) infants and a considerably higher percentage of newborn deaths than mothers with care.

Genetic and environmental factors, including prenatal care, which had significant associations with birth weights, major malformations, and newborn deaths were identified. After the effects of these factors were accounted for, prenatal care remained significantly associated with birth weights and newborn deaths but not with major malformations.



Mother and her young child in a Navajo home await a health team. Teams make home visits to provide maternal and child health services.