product compared with only 30 percent for the United States) (*13*).

Another valuable lesson is that government programs can provide extremely high-quality services. The American people and government officials might well ponder this accomplishment.

None of the services we have described offer complete solutions to any of the problems associated with providing appropriate care for the growing numbers of dependent elderly in our populations, but they may generate some insights of fresh ways to approach problems that will move us closer to our goal.

References

1. Ministry of Housing: Institutions and housing for the elderly and the handicapped in Denmark. Copenhagen, 1979.
2. Anderson, E.: Institutions for the elderly: present State and development trends. Dan Med Bull 29: 156-158 (1982).
3. Willadsen, J.: Psychiatric services for the elderly. Dan Med Bull 29: 166-169 (1982).
4. Gutterman, S., and Dobson, A.: Special report: impact of Medicare prospective payment system for hospitals. Health Care Financing Rev 7: 97-114 (1986).
5. Levit, K., et al.: National health expenditures, 1984. Health Care Financing Rev 7: 1-35 (1984).
6. Waldo, D.: National health expenditures, 1985. Health Care Financing Rev 8: 1-21 (1986).
7. Adams, E., and Schlenker, R. E.: Case-mix reimbursement for nursing homes services: simulation approaches. Health Care Financing Rev 8: 35-45 (1986).
8. Weissert, W., Scanlon, W., Wan, T., and Skinner, D.: Care for the chronically ill: nursing home incentive payment experiment. Health Care Financing Rev 5: 41-49 (1983).
9. Meiners, M.: The case for long-term care insurance. Health Affairs 2: 55-79 (1983).
10. Weissert, W.: Seven reasons why it is so difficult to make home and community based long-term care cost-effective. Health Services Res 20: 432-433 (1985).
11. U.S. Department of Health and Human Services: The evaluation of the national long term care demonstration: final report. Mathematica Policy Research, Inc. Princeton, NJ, May 1986.
12. Weissert, W.: Hard choices: targeting long-term care to the "at risk" aged. J Health Polit Policy Law 11: 463-574, fall 1986.
13. Rachlin, S.: Danes—'Some of the world's big doubters'. New York Times—The Week in Review, Nov. 30, 1986.

Birth Weight and Subsequent Growth Among Navajo Children

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Synopsis

An examination of length, weight, and birth weight data routinely collected from the clinics supported by the Navajo Nation Special Supplemental Program for Women, Infants, and Children (WIC) showed an association between birth weight and subsequent growth status. Navajo children less than 2 years of age entering the WIC Program were divided into low, normal, and high birth weight groups, and their growth patterns were plotted when they returned periodically for reassessment.

Overall, the children tended to have low length-for-age and high weight-for-length measures, relative to the reference population, that suggest suboptimal nutritional status. Children with birth weights less than 2,500 grams (g) were consistently shorter, lighter, and thinner than children with birth weights greater than 2,500 g. Although the overall growth status of the children improved between 1975 and 1980, the growth among the children with low birth weights never fully caught up with that of the other Navajo children. Moreover, during that period, the normal birth weight group had a modest improvement in length-for-age relative to the reference population, but the low birth weight group did not. These findings suggest that prenatal interventions to improve the birth weight status of Navajo infants may result in improving the growth status of Navajo children.

ACCORDING TO DATA COLLECTED from the nutrition surveillance system coordinated by the Centers for Disease Control (CDC), Native American preschoolers have a high prevalence of growth retardation compared with the international reference population (*1*). Previous studies have shown a strong association between birth weight and subsequent growth patterns (*2–7*); low birth weight (LBW) may be an important factor of growth among children with nutritional deficiencies. However, birth weight information from the surveillance data had not been evaluated in terms of birth weight as a factor of growth among Native American children.

In this paper we examine nutrition surveillance data collected routinely between 1975 and 1980 from Native American children less than 2 years old who visited clinics of the Special Supplemental Food Program for Women, Infants, and Children (WIC) on the Navajo Nation reservation. We focus principally on the relationship between birth weight and growth status of these children. Further, we compare trends in the growth status of low and normal birth weight children for the periods 1975–77 and 1978–80 to determine whether the relationships between birth weight and postnatal growth have changed.

Methods

The Navajo are the most numerous of all Native American groups in the United States. In 1981 there were about 151,000 Navajos, most of whom lived a basically rural existence on or near the 27,000-square-mile reservation that is located in Arizona, New Mexico, and Utah. The Navajo Nation's WIC Program was instituted concurrently with nutrition surveillance on the reservation in 1975 with assistance from the State of Arizona. During the initial and subsequent visits of each infant, identifying information was recorded along with the dates of birth, birth weights, lengths, and weights by Indian Health Service and WIC staff. According to protocol, the children's weights were measured to the nearest one-fourth pound after removing their shoes and outer clothing. Recumbent lengths were determined for children less than 2 years of age; they were measured supine with legs fully extended. Length measurements were recorded to the nearest one-eighth inch. Birth weights were recorded from health records issued at area hospitals to the children's parents. Children without known birth weights were included only in the total birth weight group. Gestational age data were generally unavailable on the reservation and not reported; thus it is not possible in this study to estimate the proportion of LBWs that might have resulted from intrauterine growth retardation (IUGR).

Not all the Navajo Nation infants and toddlers were included in the study. Those who were monitored did not constitute a random sample of all Navajo preschool children but rather a large, self-selected subsample comprising the children who reported periodically to the WIC clinics for nutrition evaluation. However, the Navajo Nation reservation was especially suitable for studies based on surveillance data because, during the study period, the population was relatively clearly defined and ethnically homogeneous; virtually all infants were eligible to enter the WIC Program. A number of the children were located in remote areas lacking all-weather roads and easy access to health facilities—between 1975 and 1980 one of the primary reasons for nonparticipation in WIC was geographic inaccessibility—and no statistics were available concerning those children. However, the Navajo surveillance data set was, and is, the most robust and complete source of its kind.

Measurements from initial and all subsequent clinic visits—ideally at 6-month intervals—were collected in the study to describe the nutritional status of the children in the surveillance system. Although the age values were rounded to the nearest month for stratification into age groupings for the study, the exact ages (as derived by subtracting the dates of birth from the dates of clinic visits) were used to compute anthropometric indices.

To evaluate the children's nutritional status, the length and weight values were compared with the National Centers for Health Statistics–Centers for Disease Control (NCHS–CDC) reference population of children of the same age and sex with the use of a CDC-developed computer subroutine (*1*). Since the NCHS–CDC reference population does not provide reference values for infants shorter than 49 centimeters (cm), accurate weight-for-length percentiles for extremely young or short children could not be computed. So that small infants were not selectively excluded from the analysis (52.9 percent of LBW infants who were under 3 months of age were less than 49 cm in length), weight-for-length percentiles were analyzed only for those infants 3 months of age and older, by which time all the infants were taller than 49

Table 1. Number of infants making initial and reassessment visits,[1] by age group and birth weight category, Navajo Nation Special Supplemental Food Program for Women, Infants, and Children, 1975–80

Age (months)	1,000–2,499 g birth weight Initial visit	Reassessment visit	Total	Percent retained	2,500–3,999 g birth weight Initial visit	Reassessment visit	Total	Percent retained	4,000–6,000 g birth weight Initial visit	Reassessment visit	Total	Percent retained	Unknown birth weight Initial visit	Reassessment visit	Total	Total visits
5	999	6	1,005	...	9,492	76	9,568	...	735	10	745	...	762	28	790	12,108
6–11	202	635	837	83.3	2,162	6,021	8,183	85.5	146	487	633	85.0	622	310	932	10,585
12–17	115	624	739	73.5	1,368	5,922	7,290	76.2	94	489	583	78.3	545	408	953	9,565
17–23	101	588	689	68.6	1,050	5,435	6,485	67.8	66	430	496	66.6	579	534	1,113	8,783
Total	1,417	1,853	3,270	...	14,072	17,454	31,526	...	1,041	1,416	2,457	...	2,508	1,280	3,788	41,041

[1]This table does not include 337 clinic visits of unknown type (initial or reassessment). However, visits of unknown type were included in the analysis of all types of visits combined.

Table 2. Prevalence of low anthropometric percentiles (below 5th percentile, Z scores less than 1.65) for all infants in all birth weight groups,[1] by age: all clinic visits, Navajo Nation Special Supplemental Food Program for Women, Infants, and Children, 1975–80

Age (months)	Length-for-age Number	Percent	Weight-for-age Number	Percent	Weight-for-length Number	Percent
Less than:						
2	7,066	11.2	7,017	10.1	...	...
2–3	2,933	12.5	2,952	7.7	1,146	4.2
4–5	1,656	12.0	1,661	6.0	1,651	4.8
6–7	5,414	8.6	5,379	4.4	5,355	3.4
8–9	2,965	10.8	2,966	8.2	2,937	4.6
10–11	2,039	12.0	2,011	8.8	1,988	5.6
12–13	4,700	10.8	4,650	6.8	4,624	3.5
14–15	2,746	14.8	2,717	7.3	2,699	4.6
16–17	2,032	14.4	1,998	7.5	1,982	4.2
18–19	3,995	12.3	3,900	6.0	3,878	3.0
20–21	2,629	15.4	2,588	6.2	2,568	3.9
22–23	2,090	15.6	2,052	6.3	2,019	3.9
Total	40,265	...	39,891	...	30,857	...

[1]Includes anthropometric values for infants whose birth weights are unknown.

cm. Values less than the 5th percentile of the reference population for length-for-age, weight-for-length, or weight-for-age, and those greater than the 95th percentile of the reference for weight-for-length were defined as potentially abnormal values. Both the prevalence of these anthropometric values below the fifth percentile and the mean percentiles were examined. Percentiles for the anthropometric indices mentioned were derived from the mean of the Z scores for each index. The prevalence of abnormalities and mean percentiles were examined within three birth weight categories (low, 1,000-2,499 g; normal, 2,500-3,999 g; and high, 4,000-6,000 g) and for all birth weight categories (including unknown birth weight) combined. Because a small portion of the birth weight data may have been based on the mothers recalling the weights, broad birth weight categories were constructed to minimize the possibility of misclassification.

To test the significance between differences in growth patterns occurring between age and birth weight groups, and over time, the procedure used for analyzing the variance of the mean anthropometric values was the Statistical Analysis System (SAS) for general linear models (GLM) (*8*). This procedure permitted us to determine to what extent the differences in growth might result from differences between age groups or from differences between periods.

Results

Between 1975 and 1980, a total of 19,038 and a yearly average of 3,173 Navajo children from birth to 24 months of age were screened in Navajo Nation WIC Clinics. A total of 41,041 WIC clinic visits was made; on 37,590 of these visits both anthropometric and birth weight information was collected. A number of children left the WIC Program during the study period and were lost to followup. However, the retention rate was approximately the same (that is, between 66.6 and 68.6 percent) among all birth weight groups (table 1).

Between 1975 and 1980, birth weight values were recorded at 86.8 percent of the screening and 94.0 percent of the reassessment visits. The yearly prevalence of LBWs among infants screened between 1975 and 1980 ranged from 7.3 percent to 10.8 percent and was slightly higher among those born between 1973 and 1976 (9.6 percent) than those born between 1977 and 1980 (7.8 percent).

The mean length-for-age, weight-for-age, and weight-for-length percentiles for children from all birth weight groups for all clinic visits made between 1975 and 1980 are presented in fig. 1. The

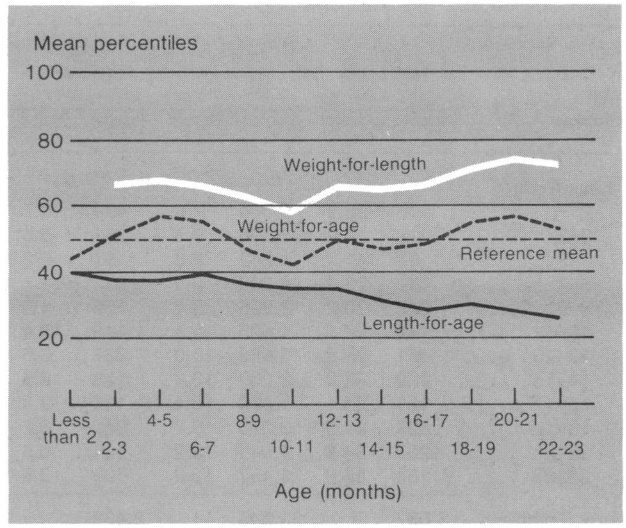
Navajo children in the surveillance group most closely resemble the reference population in the weight-for-age index. The mean length-for-age is between 10.6 and 12.5 percentile points below the reference mean during the first 7 months of life; the relative deficit gradually increases through the second year, when it reaches 24.0 percentile points below the reference mean. By contrast, the mean weight-for-length of the Navajo children ranges between 9.1 and 24.4 percentile points higher than the reference mean. The temporary decrease in mean weight-for-age and weight-for-length that occurs between ages 8 and 11 months is not clearly understood, but it may reflect changes in food intake related to the process of weaning and introduction of solid foods.

The prevalence of low weight-for-length is slightly lower in the surveillance population than the 5 percent expected for the reference population, whereas the prevalence of low weight-for-age is slightly higher and the prevalence of low length-for-age is much higher in the surveillance than in the reference population. For children under 10 months, the prevalence of low length-for-age ranged from 8.6 percent to 12.5 percent and rose to between 10.8 percent and 15.6 percent for children 10 months of age and older (table 2).

Effect of birth weight. When the anthropometric indices are stratified by birth weight, distinctly different growth outcomes emerge for each birth weight group. Children with LBW who are less than 2 months of age have a mean length-for-age percentile of only 3.5, nearly 47 points below the reference mean (fig. 2). The mean value then increases to a peak percentile of 15.8 for children who are 12–13 months of age. Rather than continuing to catch up with the mean length-for-age percentiles of normal birth weight children between ages 14 and 23 months, those of the LBW children gradually decline from 15.3 to 11.9.

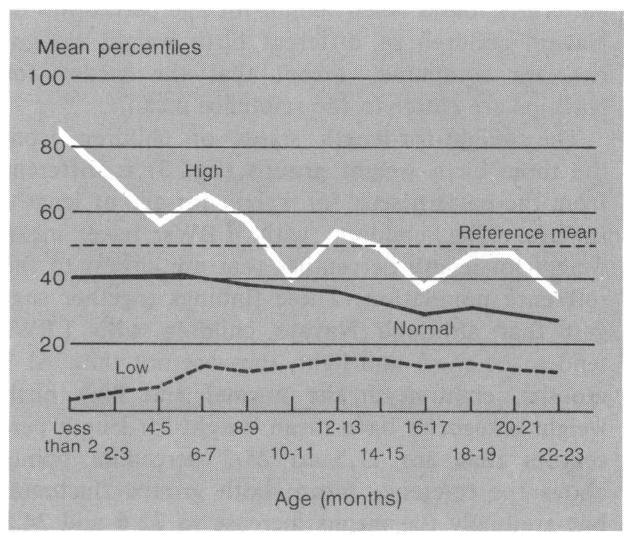
The children with normal birth weights who are less than 2 months of age have a mean length-for-age percentile of 40.6, about 10 percentile points below the reference. The relative growth deficit gradually increases through the second year, when the mean length-for-age percentile reaches a low of 27.5. By contrast, the children with high birth weights who are less than 2 months old have a mean length-for-age percentile of 81.4, but by age 10–11 months they actually fall 10.4 percentile points below the reference mean, and there is a gradual relative decline through the second year of life. However, the high birth weight group maintains a mean length-for-age percentile that is much higher than the normal birth weight group in all age categories.

Figure 1. Mean anthropometric percentiles for infants in all birth weight groups, by age: all clinic visits, Navajo Nation Special Supplemental Food Program for Women, Infants, and Children 1975-80



NOTE: The mean percentiles were derived from *Z* scores of the reference population.

Figures 2. Mean length-for-age percentiles for infants in low (1,000-2,499 g), normal (2,500-3,999 g), and high (4,000-6,000 g) birth weight groups, by age: all clinic visits, Navajo Nation Special Supplemental Food Program for Women, Infants, and Children, 1975-80



NOTE: The mean percentiles were derived from *Z* scores of the reference population.

Similarly, the highest prevalence of low length-for-age was among Navajo children with LBWs (table 3); the prevalence decreases from 62.8 percent among the newborns to 22.2 percent for those ages 12–13 months and then remains relatively stable between 23.1 and 35.8 percent through ages 22–23 months. Throughout the first 2 years

Table 3. Prevalence of low length-for-age (below 5th percentile, *Z* scores less than 1.65) for infants in low, normal, and high birth weight groups, by age: all clinic visits, Navajo Nation Special Supplemental Food Program for Women, Infants, and Children, 1975–80

Age (months)	Low birth weight (1,000–2,499 g) Number	Percent	Normal birth weight (2,500–3,999 g) Number	Percent	High birth weight (4,000–6,000 g) Number	Percent
Less than:						
2	506	62.8	5,864	7.3	429	0.7
2–3	213	47.9	2,290	9.3	201	5.5
4–5	96	41.7	1,243	8.8	97	6.2
6–7	430	28.4	4,330	6.9	359	1.1
8–9	242	30.2	2,295	9.1	156	4.5
10–11	144	27.1	1,503	10.4	115	10.4
12–13	361	22.2	3,689	10.0	337	3.6
14–15	229	32.2	2,067	13.1	128	8.6
16–17	131	23.1	1,499	13.4	118	9.3
18–19	327	27.5	3,055	10.7	259	6.2
20–21	207	34.8	1,941	13.2	124	6.5
22–23	151	35.8	1,467	13.3	109	13.8
Total	3,037	...	31,243	...	2,432	...

Table 4. Prevalence of low weight-for-length (below 5th percentile, *Z* scores less than 1.65) for infants in low, normal, and high birth weight groups, by age: all clinic visits, Navajo Nation Special Supplemental Food Program for Women, Infants, and Children, 1975–80

Age (months)	Low birth weight (1,000–2,499 g) Number	Percent	Normal birth weight (2,500–3,999 g) Number	Percent	High birth weight (4,000–6,000 g) Number	Percent
Less than:						
2	...	...	...	...	...	...
2–3	96	3.1	868	4.3	70	4.3
4–5	99	5.1	1,232	5.6	96	1.0
6–7	433	4.4	4,380	3.2	351	2.6
8–9	240	6.7	2,274	4.0	153	2.0
10–11	143	8.4	1,473	5.0	113	2.7
12–13	360	6.1	3,628	3.3	328	2.4
14–15	229	6.6	2,031	4.4	122	4.1
16–17	129	9.3	1,467	3.9	113	0.9
18–19	325	4.6	2,967	2.6	243	2.5
20–21	207	7.2	1,890	3.7	119	1.7
22–23	148	7.4	1,416	3.7	102	2.0
Total	2,409	...	23,626	...	1,810	...

of life, low length-for-age is much more common among children with LBWs than among children with normal or high birth weights. A similar pattern is found when weight-for-age percentiles of Navajo children of different birth weight categories are compared, except that the means for Navajos are closer to the reference mean.

The weight-for-length status of children from the three birth weight groups (fig. 3) is different from the pattern seen for weight-for-age or length-for-age. The children with LBWs have mean weight-for-length percentiles that are closest to the reference population. These findings together suggest that although Navajo children with LBWs tend to be short and light, they are not thin. At 3 months, children in the normal and high birth weight categories have mean weight-for-length percentiles that are 17.5 to 25.3 percentile points above the reference mean; both groups fluctuate, but gradually the means increase to 22.6 and 34.8 percentiles, respectively, above the reference by ages 22–23 months. The children with LBWs start out 7.8 percentile points above the reference at age 3 months; there is then a slight increase to 12.1 percentile points above the reference at ages 4–5 months followed by a decline to reference mean by 10–11 months and then another irregular increase to 13 percentile points above the reference at 20–21 months. Although the prevalence of low weight-for-length is close to the expected 5 percent found in the reference population, the difference between the birth weight groups is still substantial, with lower birth weight children ages 6 months and older having approximately 2 to 3 times the prevalence of thinness compared with Navajo children of normal or high birth weight (table 4). This higher prevalence of thinness among children with LBWs continues through all the age groups studied.

1975–77 versus 1978–80. The Navajo surveillance population (including all birth weight groups) making WIC visits between 1978 and 1980 had mean length-for-age percentiles that were greater than those of Navajo children making visits between 1975 and 1977 (fig. 4). For infants under 12 months of age, the differences ranged from 2.1 to 9.4 percentile points and were significant ($P < .005$), suggesting an improvement in stature, especially for the younger children.

When the mean length-for-age percentiles over time are stratified by birth weight category, children with normal birth weight who were measured between 1978 and 1980 show a similar improvement in growth status, relative to the reference, over those measured between 1975 and 1977 (fig. 5). For those normal birth weight children under 12 months of age, the differences ranged from 1.8 to 9.2 percentile points and were significant ($P < .005$).

However, for the children with low birth weight, there was no significant difference in mean length-for-age percentiles between those measured during the periods 1975–77 and 1978–80; there was no improvement in their stature (fig. 6).

Discussion

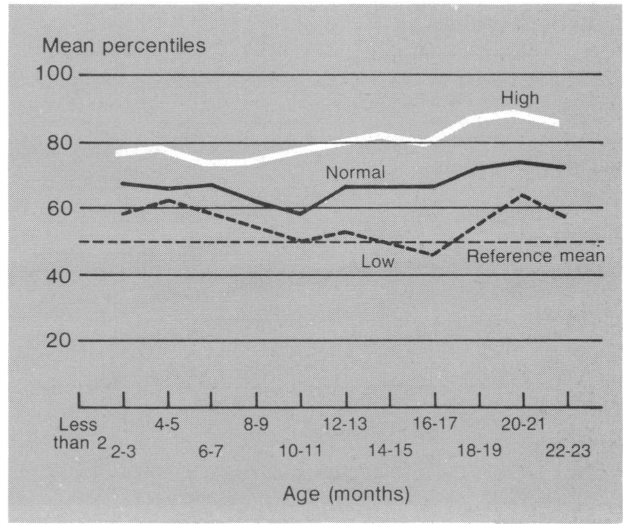
In this study, length and weight values of preschool children less than 2 years of age in the Navajo Nation who attended WIC clinics between 1975 and 1980 were converted to sex- and age-specific percentiles of the NCHS-CDC reference population and examined within three birth weight groups. The LBW group had the lowest mean length-for-age, weight-for-age, and weight-for-length percentiles; they also had the highest prevalence of low length-for-age and weight-for-length. Comparison of the mean length-for-age percentiles of children measured from 1975 to 1977 with those of children measured from 1979 to 1980 showed some overall improvement, relative to the reference, among normal birth weight children but not among LBW children.

Participant dropout is a potential problem in any study. In general, there is a decreasing probability of being a WIC participant as a child grows older, and if certain categories of children leave in greater relative numbers a bias will be introduced. However, during the study period, continuing eligibility was virtually universal for Navajo residents of the reservation. Moreover, the retention rate for Navajo WIC participants was approximately the same for children in all three birth weight categories (table 1).

The weight-for-length data for all birth weight groups combined suggest that thinness or acute undernutrition was not a major public health problem among Navajo Nation children monitored by the surveillance system (table 2). These findings are consistent with the observations of Van Duzen and coauthors (*9*), who noted a significant improvement (that is, less acute undernutrition) in the nutritional state of reservation children after various supplemental feeding programs were introduced in 1968. However, children with LBWs reported in this study have a relatively high prevalence of thinness that persists.

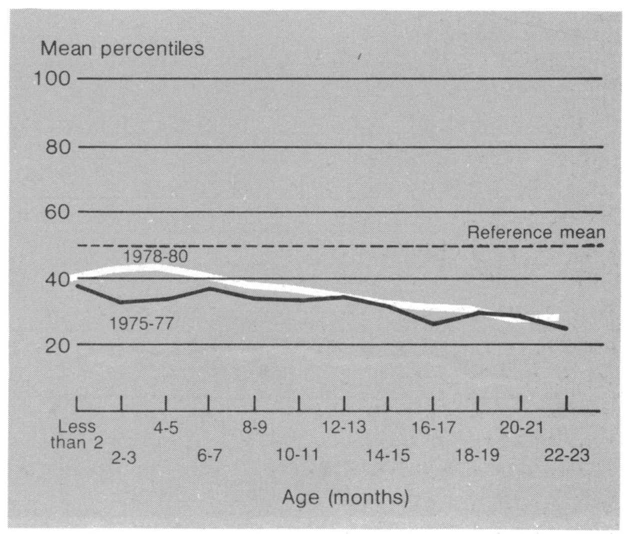
Regarding the postnatal growth improvement of the normal birth weight children, one possible contributing factor was an increasing tendency among Navajo mothers to breast feed. In 1979 the Navajo WIC Program began a vigorous promotion of breast feeding among participating mothers (unpublished Navajo Women, Infants, and Children Program reports for fiscal years 1978–79 and 1979–80, and July–December 1980; also Burkhalter, B. R., Ritenbaugh, C. K., Harrison, G. G.: Trends in infant feeding among southwest American Indians: 1900–1980. A 1981 unpublished report prepared for the Department of Family and Community Medicine, University of Arizona, Tucson, AZ). A subsequent unpublished WIC study of more than 1,000 children under 12

Figure 3. Mean weight-for-length percentiles for infants in low (1,000-2,499 g), normal (2,500-3,999 g), and high (4,000-6,000 g) birth weight groups, by age: all clinic visits, Navajo Nation Special Supplemental Food Program for Women, Infants, and Children, 1975-80



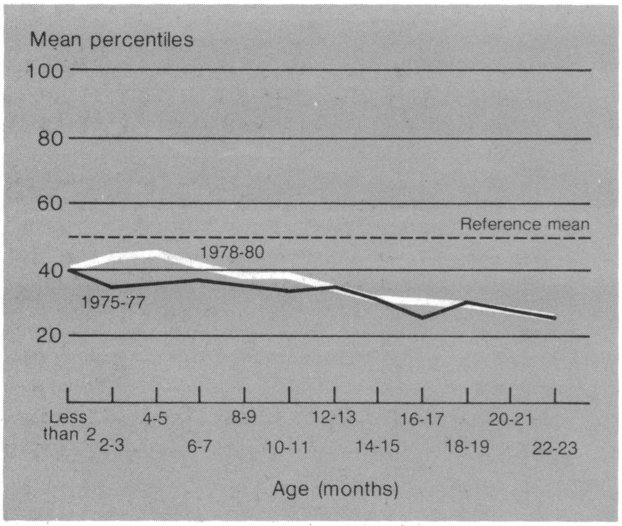
NOTE: The mean percentiles were derived from *Z* scores of the reference population.

Figure 4. Mean length-for-age percentiles for 1975-77 and 1978-80 for infants in all birth weight groups, by age: all clinic visits, Navajo Nation Special Supplemental Food Program for Women, Infants, and Children, 1975-80



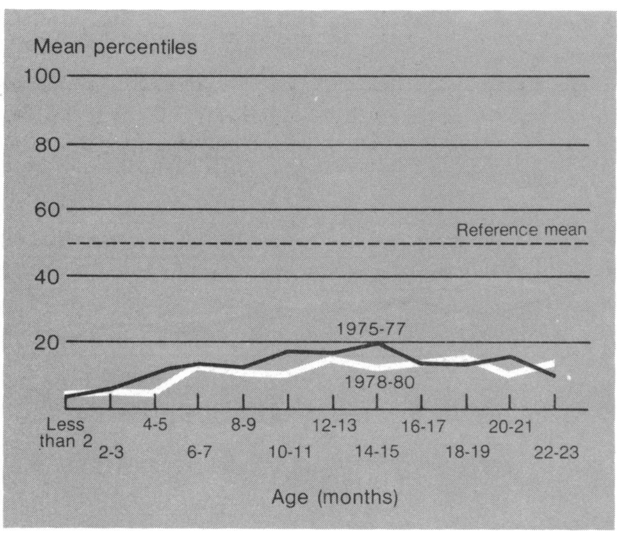
NOTE: The mean percentiles were derived from *Z* scores of the reference population.

Figure 5. Mean length-for-age percentiles for 1975-77 and 1978-80 for infants in the normal birth weight group (2,500-3,999 g), by age: all clinic visits, Navajo Nation Special Supplemental Food Program for Women, Infants, and Children, 1975-80



NOTE: The mean percentiles were derived from *Z* scores of the reference population.

Figure 6. Mean length-for-age percentiles for 1975-77 and 1978-80 for infants in the low birth weight group (1,000-2,499 g), by age: all clinic visits, Navajo Nation Special Supplemental Food Program for Women, Infants, and Children, 1975-80



NOTE: The mean percentiles were derived from *Z* scores of the reference population.

months born to reservation mothers found that the prevalence of breast feeding increased from about 26 percent during 1978–79 to around 39 percent during 1979–80. Moreover, there was an increase in the percentage of those infants receiving breast milk for more than 2 months—from about 17 percent to 25 percent. It is possible that the increased tendency to breast feed after 1979, in addition to other WIC-endorsed activities and changes (that is, initiation of feeding programs) on the reservation noted by Van Duzen and coauthors (*9*), may have contributed to the positive shift noted among children having normal birth weights.

Although the younger Navajo children in WIC with normal birth weights showed improvement between the periods 1975–77 and 1978—80 in linear growth relative to the reference population, the children with LBWs did not. The data indicate that the children with LBWs are predisposed to relative shortness, and the factors that helped the normal birth weight children to improve their growth have not changed that predisposition.

It is beyond the scope of this study to identify to what extent LBW children who remain smaller are genetically small (that is, have small parents), or are the victims of prenatal environmental risk factors (that is mother's alcohol abuse, smoking, educational level, age during pregnancy, and so forth); such information about the parents was not available. However, to the extent that these risk factors have been linked to an increased prevalence of LBW, we may conclude that some of the LBWs are preventable (*10*).

These results confirm that birth weight is a powerful predictor for future growth status. Not only are the LBW children shorter, lighter, and thinner in the first months of life, but these propensities persevere at least through the child's second year, despite some initial improvement.

The implication of these findings—that many of the Navajo children identified for high postnatal nutritional risk in WIC clinics may have a history of poor intrauterine growth as the primary cause of their current growth deficit—underlines the need for improved prenatal care aimed at preventing intrauterine growth failure in this population. Improved prenatal care could include two components: First, many eligible pregnant women do not enroll in WIC until after their deliveries. These women should be encouraged to enroll sooner. Kennedy and Kotelchuck (*11*) showed in a 1984 case control study that prenatal WIC enrollment has a positive impact on gestational age, mean birth weight, and the rate of LBW infants born to high-risk mothers in Massachusetts. Second, for those women who are enrolled, prenatal care should include a strong educational component regarding LBW risk factors beyond the regular nutritional supplementation and nutrition education. Although the surveillance data as presently collected cannot be used to distinguish between LBW from prematurity and IUGR, by including more at-risk pregnant women and supplementing the present WIC Program to include education on nonnutritional behavioral risk factors for LBW, both categories of potentially LBW infants may benefit.

The analysis of surveillance data that are gathered during WIC visits offers some important advantages. The data set is large and relates to populations that need medical scrutiny because of increased health and nutritional risks. Moreover, because the surveillance system is continual, trends in the prevalence of abnormalities can be tracked.

The surveillance data also have important limitations. Of particular significance is the lack of accurate gestational information, which makes it impossible to evaluate the intrauterine growth of these children. Another limitation is the lack of information with which to characterize socioeconomic status. Without data on more specific behavior-related factors such as alcohol use, smoking, health knowledge, dietary habits, access to and use of medical care, and breast feeding practices, it is not possible to evaluate definitively whether the observed association between birth weight and postnatal growth is a causal relationship or attributable to common relationships with social, economic, and related behavioral factors; that investigation awaits a more controlled scientific study which is outside the grasp of the surveillance system. However, despite the inability to demonstrate a causal relationship from these data, the association of LBW with reduced growth is both biologically plausible and consistent with the findings of other studies (*2–7*). Thus, apart from the issue of whether nutritional or other interventions can ameliorate the effects of LBW on growth, it is clear that reducing prenatal risk factors for LBW (which are not traditional components of many WIC Programs) and increased use of prenatal medical care should be stressed along with attention to nutrition to lessen the chances that mothers will have LBW infants.

In summary, our analysis suggests that much of the nutritional risk as indicated by growth abnormality among the Navajo infants may be attributable to the persistent effects of poor intrauterine growth and LBW. More disturbing is the fact that these LBW infants are also those who have failed to improve their growth status, at least through age 24 months. In contrast, the infants of normal birth weight, although shorter than the reference population, have shown improved growth over time. Thus, prenatal programs aimed at preventing LBW may be more effective than postnatal programs designed to promote growth among LBW infants.

References

1. National Center for Health Statistics: NCHS growth curves for children: birth–18 years. DHEW Publication No. (PHS) 78-1650. U.S. Government Printing Office, Washington, DC, 1977.

2. Fisch, R. O., Bilek, M., and Ulstrom, R.: Obesity and leanness at birth and their relationship to body habitus in later childhood. Pediatrics 56: 521–528 (1975).

3. Charney, E., et al.: Childhood antecedents of adult obesity. N Engl J Med 295: 6–9, July 1, 1976.

4. Clarkson, J. E., Silva, P. A., Buckfield, P. M., and Hardman, J.: The later growth of children who were preterm and small for gestational age. New Zealand Med J 81: 279–282 (1975).

5. Kinoshita, K., Nakagawa, T., and Ibaragi, K.: Statistical analysis of birthweight and postnatal growth. Acta Obstet Gynecol Jpn 23: 89–95 (1976).

6. Bjerre, I.: Physical growth of 5-year old children with a low birthweight. Acta Paediatr Scand 64: 33–43 (1975).

7. Cruse, M. O.: A longitudinal study of the growth of low birth weight infants. Pediatrics 51: 620–628 (1973).

8. SAS Institute, Inc.: SAS user's guide: statistics, version 5 edition. SAS Institute, Inc., Cary, NC, 1985, pp. 433–506.

9. Van Duzen, J., Carter, J. P., and Vander Zwagg, R.: Protein and calorie malnutrition among preschool Navajo Indian children, a follow-up. Am J Clin Nutr 29: 657–662 (1976).

10. Metcoff, J., et al.: Maternal nutrition and fetal outcome. Am J Clin Nutr 34: 708–721 (1981).

11. Kennedy, E. T., and Kotelchuck, M.: The effect of WIC supplemental feeding on birth weight: a case-control analysis. Am J Clin Nutr 40: 579–585 (1984)