

Original Communications**Relationship of Morbidity to the Feeding Patterns of Navajo Children from Birth Through Twenty-Four Months^{1,2}**JEAN G. FRENCH, DR. P.H.³

IT IS RECOGNIZED that nutrition is intimately related to the growth, development, and general state of health of the child. In the so-called underdeveloped areas of the world where large numbers of children are undernourished, the morbidity and mortality rates are frequently higher than in countries with a better standard of nutrition. The study "A Thousand Families in New Castle on the Tyne" by Spence et al. (1) demonstrated repeatedly that poor nutrition and poor maternal care intensified the severity of infectious disease. On the basis of investigations in Jamaica, British West Indies, Wills and Waterlow (2) observed that a high death rate in the age group 1-4 may serve as an index to malnutrition.

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Studies conducted by the Cornell-Navajo Project on the Navajo Indian Reservation, an area which simulates conditions of a so-called underdeveloped region, showed a high morbidity and mortality rate in Navajo children from birth up to 2 years of age. Infectious diseases are the major cause of these rates and gastroenteritis is the single major cause. A study of the etiologic agents responsible for gastroenteritis in the project population was conducted by the project staff and failed to incriminate ova and parasites as a cause for gastroenteritis. Approximately 10% of the total cases of gastroenteritis were found to be caused by enteropathogens such as *Salmonella*, *Shigella*, *Proteus*, and *Escherichia coli*. Attempts were made to ascertain the cause for the remaining 90% of the cases and a study of the role of viruses as etiologic agents was undertaken but failed to reveal any significant findings. It was suggested that poor nutrition, particularly defective feeding patterns, may contribute to and intensify the problem of infectious disease and gastroenteritis in particular, but little was known about the feeding patterns of Navajo children.

The purposes of this study then were to



determine the content of the diet and the method of feeding Navajo children from birth to 2 years of age and to study the association of feeding patterns with the growth pattern and morbidity experience of the child.

METHODS

The present study was conducted in 1960 in the context of the general Cornell-Navajo research program. Descriptions of the general background of the Navajo people involved in this study have been reported in previous studies of the Cornell Research Program (3-6). Briefly, the population under study by the Cornell-Navajo Research Program consisted of 2,200 Navajos living in a 600-square-mile area of Arizona, with roughly 1,200 persons in the valley area, including Many Farms and Valley Store, and 1,000 in the more remote Rough Rock and Black Mountain area to the west. There are three points in the area where government and trading activities are conducted: Many Farms, Valley Store, and Rough Rock. The typical pattern of the Navajo is to live in family groups in a camp⁴ unit. There are 146 camps widely scattered in the 600-square-mile area.

This study group consisted of all the children in the Cornell-Navajo population born between July 1, 1958 and March 1, 1960. All the camps in this area were registered with the Cornell-Navajo Project and a complete roster of children in this age group was readily available. The total number of children in this study was 139: 72 males and 67 females. This represents the total number of children in the "Project" population in this age group, with the exception of 10 children who were off the reservation at the time of the study.

An interview questionnaire was used to get information on the feeding pattern of each child from birth up to the time of interview. All the mothers were questioned at least once and many of them were questioned again to learn if there was any change in feeding pattern since the initial interview. The interviews were

⁴ A camp is a cluster of dwelling units known as hogans which usually comprise a family made up of a mother and her married daughters and their families.

conducted by the author and health visitors both in the clinic and in the field. Since the author did not speak Navajo and few of the mothers spoke English it was necessary to use health visitors as interpreters for the major portion of the interviews.

Observations were made by the author in the hogan of the methods used to feed these children. A stratified random sample was used, the stratification being by age, geographic location, and whether breast fed or bottle fed. The project statistician did not think a large sample size was necessary for these observations since previous studies had shown we were dealing with a homogeneous population in each geographic location with respect to environmental conditions, cultural patterns, and socioeconomic status. The visits were unscheduled so that no special preparation would be made for the visit on the part of the family. In some cases the baby was being fed during the observer's visit but in other situations the answers to questions regarding feeding methods were all that could be obtained.

During these visits samples of the milk that was being consumed by the bottle fed babies were taken whenever possible. This was done by the use of a sterile applicator in nutrient broth. A swab was taken of the inside of the nipple, of the inside of the bottle, and of the milk itself. The laboratory procedures for these samples consisted of culture on EMB⁵ agar plates and blood agar plates for study of possible enteropathogens, streptococcus, and staphylococcus.

The growth information on these children was gleaned from the clinic charts at Many Farms Clinic and other medical facilities attended by the project population: Chinle Clinic, Rock Point Clinic, Ganado Hospital, and the Fort Defiance Indian Hospital. At the time this study was conducted many of the births occurred in the hogan without medical attendance and, therefore, in many cases no record was available of the birth weight. The Navajos were accustomed to bringing their children to a medical facility only when the child appeared ill and although attempts were made by the project staff to have well baby clinics many of the

⁵ Eosin-methylene blue.

heights and weights were taken at a time when the child was ill.

The morbidity information was obtained from clinic records at the facilities mentioned above.

RESULTS

The pattern of milk feeding in Navajo children from birth to 24 months is shown in Fig. 1. At birth 73% of the children were breast fed, 17% were given the bottle and breast, and 10% were bottle fed only. The major portion of the babies who started on both the breast and the bottle at birth were eventually changed to bottle feedings alone. Of the 101 babies originally started on breast milk alone, 21% were changed to artificial feeding, most of them within the first 9 months. At the age of 15 months over 51% of the 45 babies on whom a feeding history was available for that period of time were still breast fed, and of the nine children followed to 24 months five, or 55%, were still breast fed. No weaning either from the bottle or breast occurred until 12 months of age, and when weaning did occur many of the children received no milk at all.

In those babies that were breast fed at birth 30.6% were born at home and the remainder were born in a hospital or some other medical facility. In those children receiving the bottle or bottle and breast at birth, 42% of them were born at home and the remainder at some medical facility.

The percent of breast fed babies was approximately the same in each geographic location of the study area. The percent of solely bottle fed babies was almost twice as high in the Rough Rock area as in the Many Farms-Valley area. The percent of babies receiving no milk after weaning was higher in the Many Farms-Valley area than in the Rough Rock area. The Many Farms-Valley area is accessible to trading post and medical clinics. The Rough Rock area

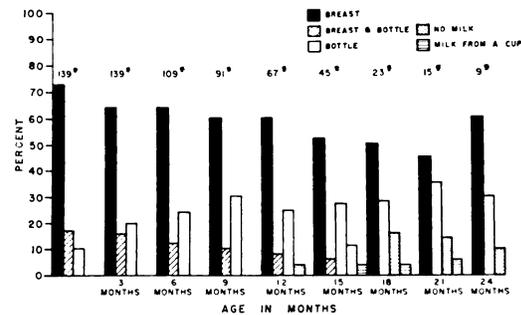


FIG. 1. Percent distribution of milk-feeding patterns from birth through 24 months of age. Asterisk indicates actual number of children.

has one trading post but is not close to any medical facilities, and the Black Mountain area is far removed from both trading post and medical clinics.

The following reasons were given by the mothers for starting their babies on artificial feedings:

insufficient breast milk	28
employment of mother	7
hospitalization of baby	3
hospitalization of mother	2
illness of mother	1
breast abscess	1
arrival of a new baby	3
baby refused breast	3

The most commonly stated reason was that the mother did not have enough breast milk. This decision was made independently by the mother without medical advice in 23 out of 28 cases.

The mothers usually initiated the bottle feeding and decided upon the composition of the formula. The formulas were made from evaporated milk and water and the majority of the formulas did not include sugar. In the twelve cases using sugar, seven used granulated sugar, five used Karo syrup, and the amount used was 1 tsp. When the mother changed the formula herself as the baby grew older, she tended to keep the amount of evaporated milk constant but added more water, thus increasing the volume but not altering the

caloric value. In some cases the mothers changed the formula whenever the babies' stools became watery, usually by increasing the amount of milk in the formula. The formula most commonly recommended by the physicians at the various medical facilities was a half-and-half formula: at birth through 4 months, 2 oz of evaporated milk and 2 oz of water, later evaporated milk 4 oz and water 4 oz.

The frequency with which bottle feedings were offered varied from one to nine times daily with the average three times daily.

TABLE I
Life Table Based on Entry of Solid Foods into Diet of Navajo Children (Birth to 17 Months)

Age in Months	O_x	W_x	S_x	q_x	P_x	$\% l_x$
Birth	131	0	0	0	1.000	100.0
1	131	0	2	0.015	0.985	100.0
2	129	0	8	0.062	0.938	98.5
3	121	3	6	0.050	0.950	92.0
4	112	8	12	0.111	0.890	81.8
5	92	6	8	0.089	0.911	74.4
6	78	4	22	0.289	0.711	52.8
7	52	4	10	0.200	0.800	42.3
8	38	4	10	0.294	0.706	29.8
9	24	1	4	0.173	0.827	24.6
10	19	0	5	0.263	0.737	18.1
11	14	0	3	0.214	0.786	14.2
12	11	1	7	0.666	0.334	4.7
13	3	0	0	0.666	0.334	4.7
14	3	0	0	0.666	0.334	4.7
15	3	0	0	0.666	0.334	4.7
16	3	0	2	0.666	0.334	1.5
17	1	0	1	1.000	0	0

O_x = the number of children at age x months without solid food.

W_x = the number of children withdrawn from study in age interval $(x, x + 1)$.

S_x = the number of children starting solid food in age interval $(x, x + 1)$.

q_x = the probability of starting solid food in interval $(x, x + 1)$.

P_x = the probability of not starting solid food in interval $(x, x + 1)$.

l_x = the percent of children not on solid food at age x months, with $l_0 = 100$.

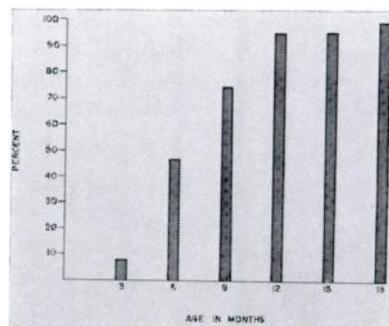


FIG. 2. Percent distribution showing age at which solid foods were introduced into diet of Navajo children (based on life table methods).

The life table in Table I and the bar graph in Fig. 2 show the age at which solid foods were added to the infants' diets. The median age at which solid foods were added was between 6 and 7 months. At the age of 9 months 24% of the children were not yet on solid food, but by the age of 1 year only 4.7% were not on solid food. The oldest age at which solid foods were added was 17 months. The type of milk feeding did not influence the age at which solid foods were introduced into the diet.

It was not possible to get an accurate account of the amount of food eaten by the children because the Navajos do not use household measures when preparing their food and usually serve the food from one common platter. Some mothers volunteered that their children ate "a lot" or "very little," but it was impossible to arrive at a more precise measurement. It was established that those children on solid foods ate three meals a day with the rest of the family and some of the older children were given sweets in between meals. The foods most frequently mentioned as composing the children's diets were potatoes, meat, bread, and cereal. Fruits and vegetables were mentioned in only half of the diets, and some parents stated they bought fruits and vegetables only when they visited the trading post which was usually once a month. Baby foods were received by only one-third of the children,

and candy, cookies, coffee, and soft drinks were mentioned in one-quarter of the diets.

Only 126 mothers were able to supply information on supplementary vitamin intake. The mothers were unable to give precise answers about the supplementary vitamin intake of their children but rather answered with such statements as "most of the time," "once in a while," or "never."

A little over 30% of the children never received supplementary vitamins and an additional 14% rarely received them.

Direct Observations of Infant Feeding

In all five cases in which breast feeding methods were observed no protective covering was used over the breast, and no hand washing or cleansing of the nipples preceded the feeding period. Although when questioned the mothers stated they alternated breasts at each feeding, this was never done during the observation visits. The mothers said they put their children to breast 9-10 times daily or whenever they cried and usually kept them at breast until they went to sleep. This was true of the older children as well as those under 6 months. Breast feeding is used as a pacifier as well as a source of food. The sucking carried on by older children appears to be more a mouthing of the nipple rather than sucking, and one might question the amount of milk obtained.

In all seven cases in which the preparation of the formula and method of feeding were observed an 8-oz can of evaporated milk was opened early in the morning and was left uncovered throughout the day without benefit of cooling. In three families the bottle was boiled every morning and the milk and water were added to the bottle for each feeding without rinsing. In one family with two bottle fed infants, the bottles were boiled only once every 2 days and the formula added to the bottles for each feeding without rinsing. In another family the bottle used for the infant's for-

mula was plastic and was never boiled although rinsed before each feeding. In four of these families the observer saw the child's bottle lying on the dirt floor of the hogan with a small amount of milk left in the bottle. The water used in making the formula was boiled water.

In all the cases observed, the mother never held the baby to feed the bottle but always propped it. The baby was never burped nor was the flow of milk checked through the nipple. In one instance an undersized baby sucked frantically on his bottle and seemed to be getting no milk. The observer asked permission of the mother to check the nipple and found it had clogged. The small baby had sucked so hard in trying to get some milk that he was quite exhausted. The mother interpreted his drowsiness to mean that he didn't want any more formula. In another case a baby of 9 months strapped in her cradle board gulped all 6 oz of her feeding in a very short time and was not burped at all during the feeding period. Shortly thereafter she burped and regurgitated the entire feeding.

Only one observation was possible of a child eating a meal with solid food. The meal consisted of mutton stew, corn, fry bread, and coffee. This 13-month-old child sat by his mother's side and was fed food that the mother took from her own serving.

Bacteriological Sampling

The bacteriological samples failed to reveal any bacterial pathogens.

Growth Information

The cumulative percent of weights below the 50th percentile⁶ from birth to 24 months is shown in Fig. 3. More than half the weights of these children from

⁶ The percentile ranking of weights and heights is based on the tables of Stuart and Associates, Department of Maternal and Child Health, Harvard School of Public Health, Boston, Massachusetts.



birth to 7.49 months were above the 50th percentile, but after that time the weights decreased sharply, so that by the age of 19 months 100% of the children were below the 50th percentile in weight.

Figure 4 shows the cumulative percent of heights below the 50th percentile from birth to 16 months. There were insufficient measurements of height available on the children over 16 months of age. The heights of these children follow the same general direction as the weights, except that they do not begin to fall below the 50th percentile at the same rapid pace as weights until age 13.5–16 months. Table II shows the relationship of heights to weights in these children. The chi-square test is significant at the 1% level showing that when weights fall below the 50th percentile, the

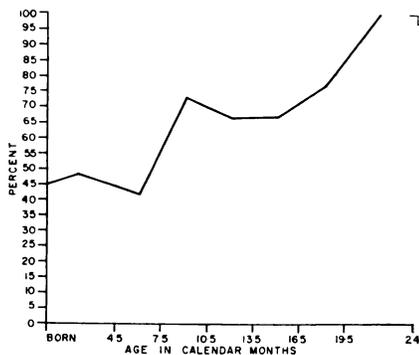


FIG. 3. Cumulative percent of weights below 50th percentile from birth to 24 months.

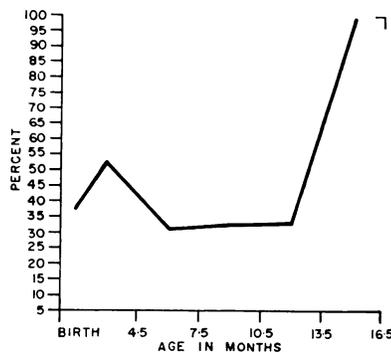


FIG. 4. Cumulative percent of heights below 50th percentile from birth through 16.5 months.

TABLE II
Relationship of Heights to Weights
by Percentile Rank

	Heights			Total
	Percentile	<50	>50	
Weights	>50	12	30	42
	<50	30	13	43
Total		42	43	85

$P \leq 0.01.$

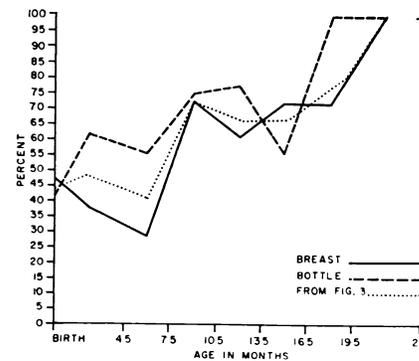


FIG. 5. Cumulative percent of weights below the 50th percentile by type of feeding.

heights also tend to fall below the 50th percentile.

The cumulative percent of weights below the 50th percentile by the type of milk feeding of the children is shown in Fig. 5. The breast fed group consists of those children who were fed solely on the breast for a period of 9 months. The bottle fed group includes those children who received bottle alone, breast and bottle, and those babies who were changed from breast to bottle before the age of 9 months. Although the babies in the breast fed category were slightly lower in weight at birth than the bottle fed babies, they showed a better weight gain through age 7.49 months than the bottle fed babies. At the age of 7.5 months the children in both groups show a marked decline in weight. This downward trend in weight continued up to the age of 24 months.

TABLE III
Morbidity Pattern of Breast Fed Navajo Babies from Birth through 24 Months

Age in Months	Total Number of Babies	All Illness		Diarrhea		Pneumonia		Otitis U.R.I.		Infectious Neuromusculature		Malnutrition		Anemia		Hospital	
		Number babies	Epi-sodes	Number babies	Epi-sodes	Number babies	Epi-sodes	Number babies	Epi-sodes	Number babies	Epi-sodes						
0-3	95	64	107	13	13	4	4	53	80	1	1	1	1	1	1	2	2
4-6	74	50	71	12	17	5	6	41	53	0	0	0	0	2	2	0	0
7-9	62	42	71	28	28	1	1	38	64	0	0	0	0	1	1	1	1
10-11	45	37	76	15	21	0	0	28	39	1	1	0	0	2	2	3	3
13-15	32	29	29	15	16	7	7	15	17	0	0	2	2	0	0	3	3
16-18	18	16	19	5	7	1	1	9	11	0	0	0	0	0	0	0	0
19-24	9	9	9	1	1	1	1	6	7	0	0	0	0	0	0	0	0
Total			382		103		20		271		2		3		6		9

U.R.I. = upper respiratory infection.

TABLE IV
Morbidity Pattern of Bottle Fed Navajo Babies from Birth through 24 Months

Age in Months	Total Number of Babies	All Illness		Diarrhea		Pneumonia		Otitis U.R.I.		Infectious Neuromusculature		Malnutrition		Anemia		Hospital	
		Number babies	Epi-sodes	Number babies	Epi-sodes	Number babies	Epi-sodes	Number babies	Epi-sodes	Number babies	Epi-sodes						
0-3	40	33	55	16	23	3	3	21	24	0	0	5	5	2	2	7	7
4-6	36	29	42	17	23	2	2	10	10	1	1	1	1	1	1	6	6
7-9	37	31	43	18	23	2	2	17	26	0	0	1	1	1	1	9	9
10-12	26	23	43	16	24	2	2	9	14	1	1	2	2	0	0	6	6
13-15	9	7	8	1	1	1	1	5	5	0	0	0	0	0	0	1	1
16-18	6	3	21	1	1	0	0	0	0	0	0	0	0	0	0	1	1
19-24	4	3	3	0	0	2	2	3	3	0	0	0	0	0	0	1	1
Total			215		95		12		82		2		9		4		31

U.R.I. = upper respiratory infection.

Morbidity

Tables III and IV are based on the morbidity data derived from the clinic charts of these children at the Many Farms Clinic and the other clinics and hospital facilities used by the project population. Table III is devoted to the morbidity experience of breast fed babies and Table IV to bottle fed babies. A baby is classified by feeding pattern according to the type of feeding he was receiving at the time of illness. Those babies receiving both the breast

and bottle were classified as bottle fed babies.

There was a higher incidence of all illnesses in bottle fed babies than in breast fed babies but this difference was not significant. There was a higher incidence of diarrhea in bottle fed babies than in breast fed babies at all ages, and this difference was significant at the 1% level from birth through 12 months.

Tables V and VI are life tables based on the hospital experience of these children



from birth through 24 months according to type of feeding. The bottle fed babies had a much higher rate of hospitalization than the breast fed babies. Figure 6 shows the expected number of hospitalized babies (arrived at by applying the hospitalization rates of breast fed babies to bottle fed babies) and the observed number of hospital experiences of the bottle fed babies. The observed number of cases was significantly higher than the expected number and this difference was greatest in the age group from birth to 9 months. After 9 months the hospital experience for both groups was almost the same. The major reason for hospitalization was gastroenteritis.

DISCUSSION

Feeding Patterns

Breast feeding was the preferred method of feeding in almost 75% of Navajo children at birth and this figure is comparable

TABLE V
Life Table Based on Hospital Experience of Breast Fed Babies

Age, Months	o_x	a_x	aw_x	W_1	W_2	h	L_x	M_x
0-3	101			0	7	2	292.5	0.0068
4-6	94	1		22	4	0	244.5	0
7-9	69	2	1	7	8	1	173.8	0.0050
10-12	56			17	2	3	139.5	0.021
13-15	37			13	2	3	88.5	0.034
16-18	22			10		0	51.0	0
19-24	12			11	1	0	18.0	0

o_x = number of children at age x months on breast feeding.

a_x = number of children admitted to study in interval $(x, x + 1)$.

aw_x = number of children admitted and lost in interval $(x, x + 1)$.

W_1 = number of children lost to study (because of follow-up failure) in interval $(x, x + 1)$.

W_2 = number of withdrawals due to close of study in interval $(x, x + 1)$.

h = number of children hospitalized in interval $(x, x + 1)$.

L_x = person months of exposure.

M_x = h/L_x .

TABLE VI
Life Table Based on Hospital Experience of Bottle Fed Babies

Age, Months	O_x	a_x	aw_x	W_1	W_2	h	L_x	M_x	Expected ^a
0-3	38	7		0		7	124.5	0.056	0.846
4-6	45	4		8	1	6	127.5	0.047	0
7-9	40	8		11	3	9	111.0	0.081	0.643
10-12	34	2		7		6	94.5	0.063	1.980
13-15	29	2		9		1	75.0	0.013	2.450
16-18	22			12		1	48.0	0.020	0
19-24	10		1	9		1	16.5	0.060	0

O_x = number of children at age x months on bottle feeding. See footnotes to Table v for other symbols.

^a Arrived at by applying the hospitalization rates of breast fed babies to bottle fed babies.

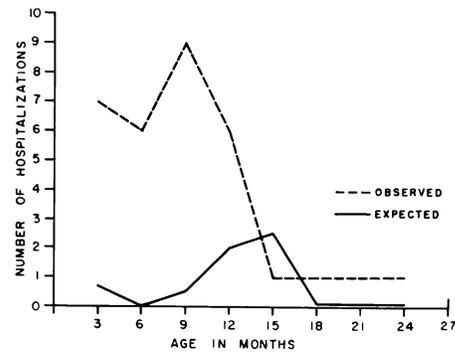


FIG. 6. Observed and expected hospitalization experience of bottle fed babies from birth through 24 months. This was arrived at by applying the hospitalization rates of breast fed babies to bottle fed babies.

to the percent of infants breast fed from birth in underdeveloped countries of the world. A somewhat unexpected result in this study was the higher percent of artificial feedings in babies born at home compared to those born in a hospital or other medical facility. Since home births were usually unattended by medical personnel, the decision for adopting artificial feeding methods was made by the mother or some other member of the family, and the composition of the formula was unsupervised by medical personnel. The higher per-

centage of artificial feedings in those children from the Rough Rock-Black Mountain area than in those from the Many Farms-Valley area indicates that proximity to a trading post or to a medical facility was not a determining factor in the adoption of artificial feedings. The Rough Rock-Black Mountain area is far distant from a medical facility and many camps in this area are not easily accessible to a trading post, but the people in this area are considered to be wealthier (based on size of herds and type of land) than the people in the Many Farms-Valley area. These findings suggest that the economic status of a family might be a factor in influencing the type of feeding pattern of their children.

The reasons given by mothers for starting their babies on artificial feedings indicate that the decision to start bottle feeding for the most part is made by the mother without benefit of medical consultation or supervision. The formulas were of questionable caloric and nutritional value due to the previously mentioned practice of adding more water to the formulas while keeping the amount of milk constant. The very frequent intervals at which the mothers changed the formulas no doubt contributed to the babies' difficulties in adjusting to the formula.

The introduction of solid foods into the diet took place on the average between 6 and 7 months of age and the range in this study was from 1 month to 17 months. The solid food component of these children's diets was lacking in fruits and vegetables in almost half the cases. A possible explanation for this lack might be that these diet histories were taken during the winter months when such foods are not readily available on the reservation. (During the summer months the Navajos eat large quantities of melons and other fruits and vegetables which they grow wherever the land will support growth.)

The data on food intake, although not based on precise measurements, strongly

suggested that these children's diets were low in calories, borderline in certain nutrients such as protein, and many of them appeared to be lacking in vitamins A and C. Further studies including biochemical assay of food intake, serum proteins, and vitamin levels should be done to evaluate more fully the dietary intake of these children.

Direct Observations of Infant Feeding

The methods used for preparing the formulas of these children as observed in this study provided ample opportunity for contamination. The facilities in the hogan are limited, and there is no source of refrigeration or running water; but even within these limitations there are certain steps that could be encouraged to provide better techniques. The fact that the bottles were boiled only once a day without benefit of cleansing between feedings is an indication of the mother's failure to comprehend sterile technique. It might be safer to teach her a simple method based on cleanliness which she could understand and carry out. The mothers should be taught to purchase 4-oz cans of evaporated milk rather than 8-oz cans to avoid having milk stand all day without benefit of refrigeration.

These observations also point out certain dangers in the present method of feeding which may contribute to the poor intake of milk on the part of the baby. These feeding methods could be improved by teaching the mother certain simple rules to follow when feeding the child, and this is applicable to breast feeding as well as bottle feeding methods.

Growth

Breast fed babies, even though slightly lower in weight at birth, showed a better weight gain than bottle fed babies during the first 7 months of life. Both groups showed a sharp decline in weight status after the 7th month. This observation is in keeping with those made by Wills and

Waterlow (2), who observed that in poor countries the effects of malnutrition are most severe in the young growing child. Even in very malnourished communities the babies in general will grow well for the first 6 months of life because they are breast fed, and the mother, even though she may be undernourished, seems to be able to provide enough milk during the early stages of lactation. At about 6 months, growth begins to fall off. This decline in weight in Navajo children occurred at the time when solid foods were added to the major portion of the children's diets and continued in spite of the continuance of solid foods.

An explanation which has been offered in the past for poor weight gain in Navajo children is that they are shorter in height than other children of their age in the United States and the lower heights of these children contributed to lower weights. Although the findings in this study show an association between heights and weights, the weights declined several months before the heights began to decline.

The weights in this study are gleaned from clinic records, and many of these weights were taken when the child was ill. It may be that the decline in weight after 7 months is a reflection of increased morbidity in these children after that age. Another explanation might be that the poor weight status of these children contributed to increased morbidity. However, regardless of which came first, the fact remains that Navajo children are below average in height and weight during the first 2 years of life. To evaluate better the weight status of Navajo children from birth through 24 months, a longitudinal study is necessary which would include taking the heights and weights of well Navajo children at 3-month intervals during their first 2 years of life.

The higher incidence of diarrhea in bottle fed than breast fed babies may be due to the opportunity for contamination which

exists in the present methods of formula preparation. Although the laboratory results failed to reveal the presence of bacterial pathogens, it is possible that an overwhelming population of saprophytes in the milk could contribute to the incidence of gastroenteritis. Another contributing factor might be that breast fed babies get a certain amount of passive transfer of antibodies from the mother through the colostrum. The work of Sussman (7) showed that the passive transfer of *Escherichia coli* antibodies occurs rarely, but when it does it may be dependent on initially high antibody titers in the colostrum.

Hospitalization serves as an index to the severity of disease, and the significantly higher incidence of hospital experiences in bottle fed babies than in breast fed babies during the first 9 months indicates that bottle fed Navajo babies are usually more severely ill than breast fed babies. The question might well be raised if the failing health of the child, ultimately resulting in hospitalization, necessitated the change from breast feeding to bottle feedings and thus created a biased picture of hospital experience in bottle fed babies. However, over half the hospitalized bottle fed babies had been on the bottle feedings for 12 weeks or longer prior to their admission to the hospital, and only three had been initially put on bottle feedings because of a hospital admission. This would seem to discredit the possibility for such a bias.

SUMMARY

This study of 139 Navajo infants from birth through 24 months of age shows breast feeding as the feeding pattern of choice in 73% of the babies at birth. Bottle feeding took place in 10% of the babies at birth; the other 17% were on both breast and bottle feedings. The place of birth did not seem to be an important factor in determining the type of feeding at birth, but economic factors might have played an important role in influencing the use of



artificial feedings. Weaning did not occur in any of the children until 12 months of age, and after weaning many of the children received no milk. The average age when solid foods were added to the diet was 6–7 months. A food intake history revealed that in general the diets of the children were low in calories. Over half were inadequate in vitamins A and C and possibly other nutrients. Quantitative studies are necessary to determine more precisely the nutritional constituents of the diets of these children.

Observation of methods used in preparing formula and in feeding indicates a need for further education of Navajo mothers in these areas. The present methods provide ample opportunity for contamination and the spread of infection.

Breast fed babies show a better gain in weight during the first 7 months of life than bottle fed babies. Both groups showed a sharp decline in weight after 7 months of age, and the decline continued through the age of 24 months.

Bottle fed babies had a significantly higher incidence of diarrhea from birth through 12 months of age than breast fed babies. There was very little difference in the experience of total illness in these two groups. The incidence of hospital experience of the bottle fed babies was significantly higher than that of the breast fed babies for the first 9 months of life, but there was no difference in the morbidity

pattern of bottle fed and breast fed babies after that time.

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