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Protein and Calorie Malnutrition Among Preschool Navajo Indian Children[1,2]

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IN THE PAST FEW YEARS much attention has been focused on the problem of protein–calorie malnutrition in the underdeveloped areas of the world. Scattered reports of kwashiorkor have been made in the United States. In 1960, Diamond and Vallbona (1) reported a case in an 11-year-old boy in Kentucky. In 1961, Dr. Charles Wolfe (2) reported three cases from the Navajo Reservation. All four of these cases were related to poverty. Another case was reported from the Bronx, New York City, by Taitz and Finberg (3). In this case, the child was on a very restricted hypoallergenic diet, and inadequate medical care, maternal ignorance, and language barriers were more at fault. In all of these instances the disease was thought to be an unusual occurrence and was not considered to be a significant nutritional problem among any group of preschool children in the United States.

Marasmus, on the other hand, has been known to occur in neglected or battered children, and in infants suffering from chronic gastroenteritis. As an entity, it is probably seen in city and charity hospitals in most major cities. The published cases, however, are usually in association with the battered-child syndrome (4).

We would like to relate more fully our experience with kwashiorkor and marasmus in patients under 5 years of age at the Public Health Service Indian Hospital in Tuba City, Arizona. We have made a systematic review of all cases admitted to the hospital during the 5-year period of 1963–1967 inclusive.

METHODS

The discharge diagnoses of all pediatric patients under 5 years of age were reviewed. The hospital charts of those with a diagnosis of malnutrition, kwashiorkor, and marasmus were examined in greater detail. The diagnosis of kwashiorkor was confirmed in:

a) Children with weight below the 3rd percentile and total protein level below 6.0 g/100 ml.

b) Children with weight below the 3rd percentile and edema, misery, and flaky-point dermatosis.

c) Children with weight below the 3rd percentile and albumin below 3.5 g/100 ml.

The diagnosis of marasmus was confirmed if the child presented with severe growth failure (fell below the 3rd percentile) and had the typical appearance of wasting with a marked loss of subcutaneous fat. The deficit in body

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weight and the clinical picture alone were considered sufficient to make a diagnosis of marasmus, regardless of whether total protein or serum albumin, or both, had been done.

In addition, the heights and weights of nearly 1,000 Navajo Head Start children were recorded and these data plotted on the Boston growth curves. The heights and weights were recorded by the Head Start teachers during the period September 1967 through February 1968. These observations were made to see if Navajo preschool children were small in stature. This smallness depends more on nutritional than genetic influences and is probably a useful adaptation to a low intake of protein and calories (5).

RESULTS

In the 5-year period of study, there were 4,355 admissions to the pediatric service of the Public Health Service Indian Hospital in Tuba City, Arizona, of children under 5 years of age. Of the total number, 616 had diagnoses of malnutrition. Fifteen had kwashiorkor and 29 had marasmus. Of the 44 children with kwashiorkor and marasmus, 35 were admitted to the hospital on more than one occasion. Twenty-two were hospitalized with diagnoses of malnutrition more than once. The average birth weight of the children with kwashiorkor was 6 lb. 4 oz, with a range of 5 lb. to 7 lb. 12 oz. For marasmus, it was 6 lb. 3 oz, with a range of 4 lb. to 8 lb.

The 572 other children not classified as having kwashiorkor or marasmus were children whose weights were below the norms for their chronological ages, and for this reason they were considered to be malnourished. They did not present with the clinical picture of marasmus and did not have edema, misery, or skin changes. Nearly 15% of all pediatric admissions during the time period, 1963 through 1967, had some form of associated malnutrition.

Table I gives the sex distribution of the cases of marasmus and kwashiorkor. There were more males with marasmus but more females with kwashiorkor.

In Fig. 1, the age distribution of the cases of marasmus and kwashiorkor is illustrated. The mean age of the infants with marasmus was 3.2 months and ranged from 1 to 7 months. The average age of the infants with kwashiorkor was 14.4 months, but they ranged from 5 to 30 months.

Mortality data are given in Table II. Fourteen (48%) of the infants with marasmus died. Two (13%) of the infants with kwashiorkor died. The reasons for their

TABLE I
Sex distribution

	Marasmus		Kwashiorkor		Total	
	Number	%	Number	%	Number	%
Males	21	72	6	40	27	61
Females	8	28	9	60	17	39
Total	29	100	15	100	44	100

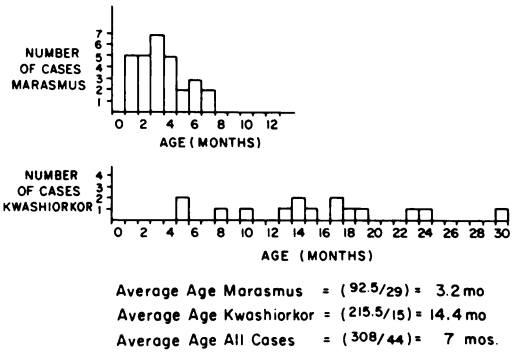

FIG. 1. Age distribution of cases of marasmus and kwashiorkor.

TABLE II
Mortality

	Marasmus		Kwashiorkor		Total	
	Number	%	Number	%	Number	%
Died	14	48	2	13	16	36
Survived	15	52	13	87	28	64
Total	29	100	15	100	44	100

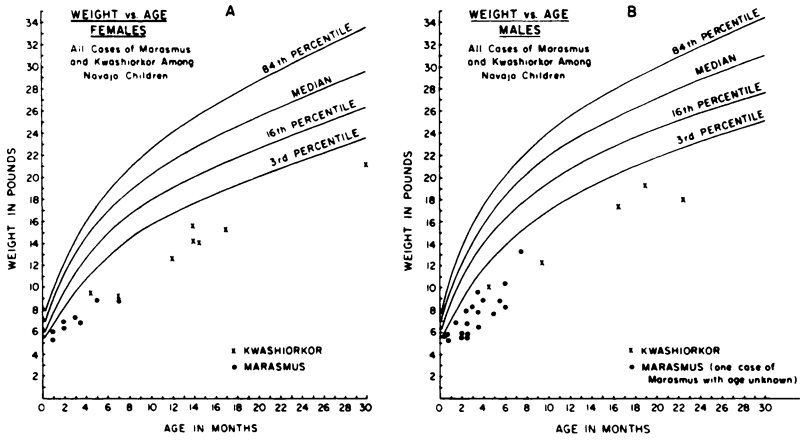

FIG. 2. Deficit in weights for cases of marasmus and kwashiorkor.

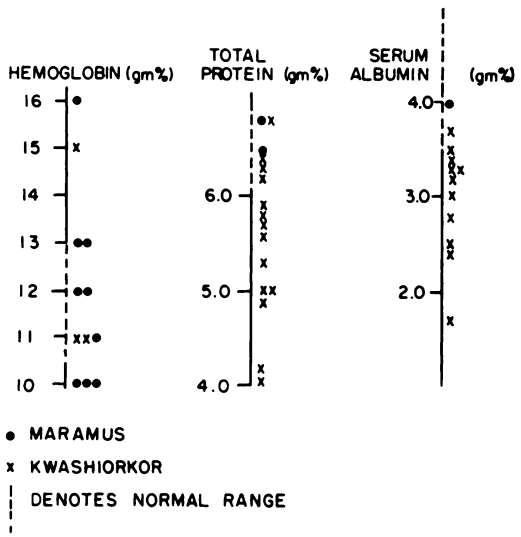

FIG. 3. Values of laboratory determinations in Navajo children with diagnosis of marasmus and kwashiorkor.

demise are discussed later and represent the end result of undernutrition and infection.

Figure 2, *A* and *B*, illustrate the deficits in weights for both males and females with marasmus and kwashiorkor. In all instances the infants were below the 3rd percentile on the Boston growth curves.

Figure 3 summarizes the laboratory determinations done on some of the cases of marasmus and kwashiorkor. The mean values are not representative of the entire group, but only those few cases who had laboratory determinations done. None of the infants had hemoglobin levels less than 10 g/100 ml. The mean total protein for 14 cases of kwashiorkor was 5.5 g/100 ml. The mean serum albumin was 2.9 g/100 ml.

One of our cases of kwashiorkor is shown during recovery in Fig. 4. Our youngest children with kwashiorkor were a pair of twins, age 5 months. The male twin was not given milk from the age of 3 weeks because the mother thought it gave him diarrhea. The female infant continued milk for 3 more weeks and then stopped. Of interest, the mother devised her own formula using canned banana flakes and water. The children got three cans of banana flakes and some rice gruel every day. One of the twins is shown in Fig. 5. Note the standing hair.

In a significant percentage of the cases, however, the diet history was unfortunately unreliable. An example is that of a 3-month-old infant with marasmus whose mother insisted that the infant consumed 60 oz of half-strength evaporated milk daily. The situation with regard to breast-feeding, however, is summarized in Table III. It is apparent that 52% of the infants with marasmus were not breast-fed. It was

impossible to tell from the hospital records whether the additional 28% were breast-fed or not. Ninety-three percent of the infants with kwashiorkor were not breast-fed. It was impossible to tell in an additional 7%. It seems clear from these data, therefore, that most of the children who developed kwashiorkor and marasmus were not breast-fed. Also, in general, the Navajo mothers who do not breast-feed are the ones who are most apt to have infants with malnutrition.

From the hospital records and the average ages of onset of marasmus and kwashiorkor, it appears clear that these infants were weaned early in life in a pattern similar to low income mothers in urban areas in developing countries and were not provided with a suitable infant formula or weaning supplement afterwards. The early weaning in the malnourished infant appears not to be a matter of choice. It is difficult to get the mothers to say definitely why they stop, but it seems that milk production decreases and ceases, or never starts in some cases. The reasons for this poor lactation performance are not ap-

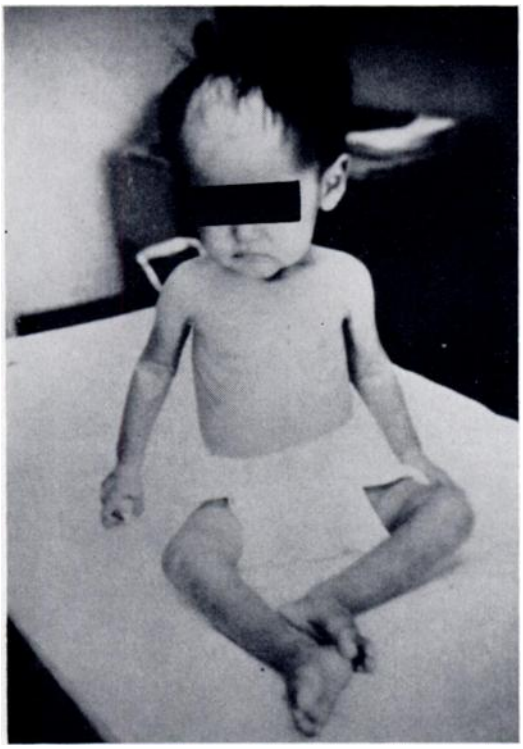

FIG. 4. A case of kwashiorkor during recovery.

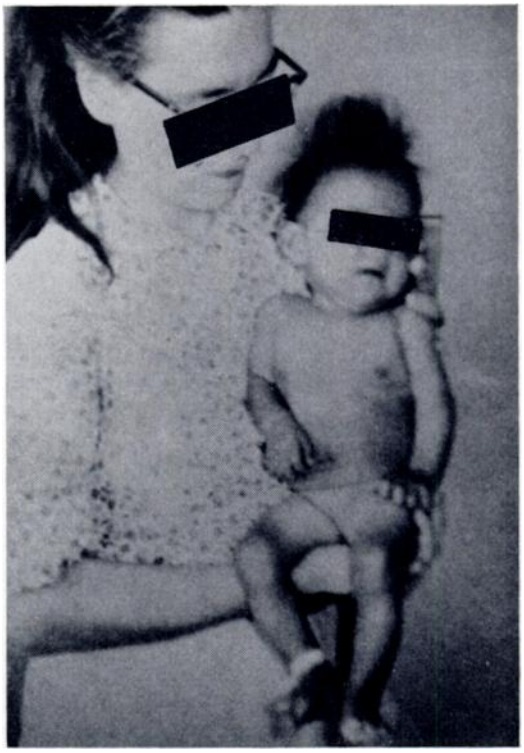

FIG. 5. One of a pair of twins with kwashiorkor, age 5 months.

TABLE III

Feeding history data from Navajo children with diagnoses of marasmus and kwashiorkor

	Marasmus		Kwashiorkor		Total	
	No.	%	No.	%	No.	%
Breast-fed only	5	17	0		5	11
Breast-fed and other	1	3	0		1	2
Not breast-fed	15	52	14	93	29	66
Feeding history unknown	8	28	1		9	20
Total	29	100	15	100	44	99

TABLE IV
Presenting complaints

	Marasmus		Kwashiorkor		Total	
	No.	%	No.	%	No.	%
Diarrhea	16	55.1	8	53.3	24	54.5
Respiratory infection	1	3.5	0	0	1	2.3
Diarrhea and respiratory infection	7	24.1	1	6.7	8	18.2
Other	5	17.3	6	40.0	11	25
Total	29	100.0	15	100.0	44	100.0

parent, but elsewhere in the world they appear to be unrelated to inadequate maternal nutrition or ill health, unless this is extreme (6).

Occasionally a mother will bottle-feed because of work, which may include sheep-herding. Also, kwashiorkor in the older child is frequently associated with displacement from the breast by a younger infant.

The role of infection in these undernourished children was assessed. In some cases the onset of symptoms of infection antedates recognition of the malnutrition. In others, the reverse was true. In nearly all the cases, information about the exact course of the history was difficult to obtain. The families invariably brought the child to the hospital because of symptoms of infection. In only four of our cases was the chief complaint loss of weight or failure to thrive. In two cases the police or a social service agency brought the child in for observation.

The presenting complaints are tabulated in Table IV. It is obvious that the most frequent presenting complaint in the cases of both marasmus and kwashiorkor was diarrhea. Diarrhea associated with a respiratory infection was also common in the infants with marasmus. In 18 out of 32 cases with diarrhea, a bacterial pathogen or other etiology for the diarrhea was demonstrated.

Gastroenteritis in infancy has always been a problem on the Navajo Indian Reservation and among other southwestern Indian tribes (7). This is probably because of poor environmental sanitation and the lack of personal hygiene. The causative organisms are frequently *Shigella, Salmonella,* and enteropathogenic *Escherichia coli.* Amebiasis also occurs. The underlying role of malnutrition has largely been ignored. We believe that the kwashiorkor and marasmus that occurs in Navajo infants is another example of the synergism between nutrition and infection described by Gordon et al. (8) as weanling diarrhea. In some cases the symptoms of infection predominate and in others the symptoms of malnutrition predominate. In the 44 cases presented in this paper the symptoms of malnutrition predominated.

In an effort to determine the prevalence of protein and calorie malnutrition in the overall population of Navajo preschool children, we obtained the heights and weights of 944 Head Start children, between the ages of 4 and 7 years, attending school in the fall of 1967 and the winter of 1968. The measurements were taken by the schoolteachers. The heights and weights were plotted on the Boston growth curves. These data are presented in Fig. 6, *A* and *B*. They show the observed and expected number of Navajo boys and girls in various height and weight percentiles according to the Boston curves. With regard to heights, nearly one-third of the children are below the 3rd percentile for Boston. With regard to weights, nearly one-tenth are below the 3rd percentile. In all cases, the differences between the observed heights and weights and the expected heights and weights are statistically significant ($P < 0.01$).

DISCUSSION

The Public Health Service Hospital at Tuba City is one of six government hospitals on the Navajo Reservation provid-

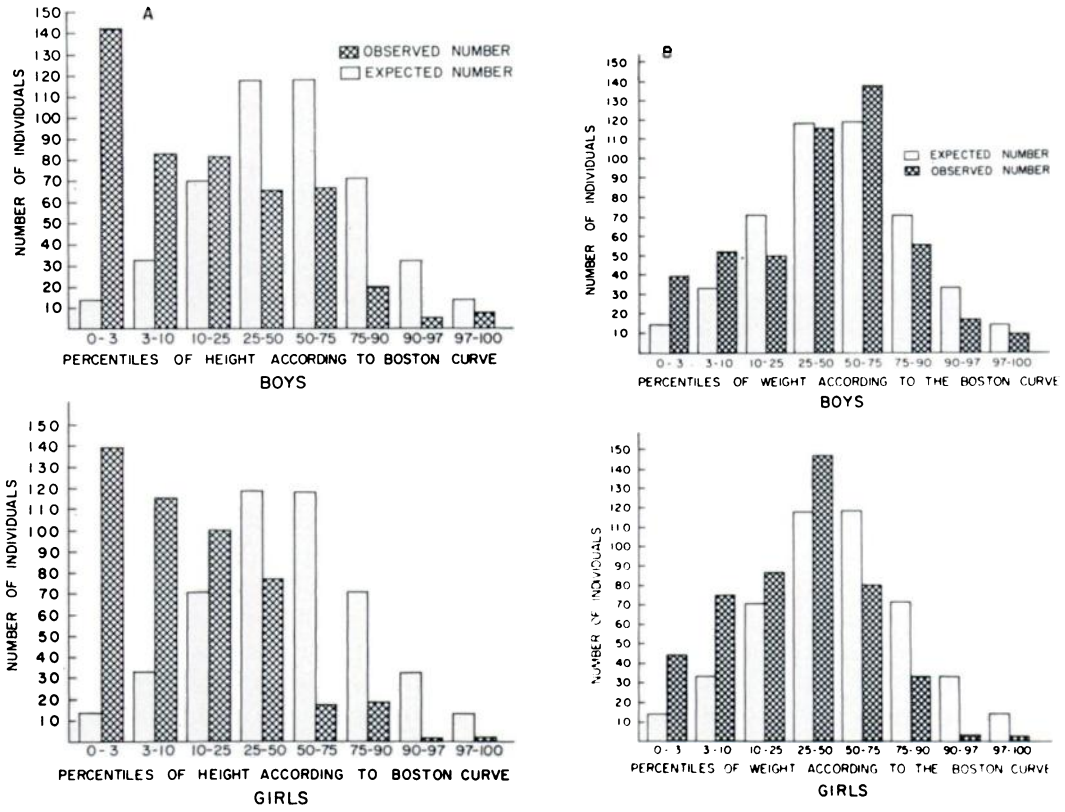

FIG. 6. Expected and observed numbers of Navajo children in various height percentiles of the Boston curve.

ing health services to the Navajo Indian. One Public Health Service hospital on the Hopi Reservation nearby also provides care for Navajo Indians. Mission hospitals and private physicians on the edge of the reservation provide additional medical care.

The Navajo Tribe is the largest Indian tribe of the United States with an estimated 121,000 people. The Tuba City Hospital provides care for an estimated 17,000 Navajos and a small number of Hopis.

The Navajo Indian traditionally lives in extended family camps scattered throughout the high desert-plateau country in the northeastern portion of Arizona, and into Utah and New Mexico. The area around Tuba City is primarily dry desert with only scattered trees, sagebrush, and sparse grass. Rainfall averages about 6 inches a year. The opportunities for agriculture, therefore, are extremely limited.

The traditional occupation of the Navajo is sheep raising. Apart from the small income obtained from sheep raising, welfare payments to eligible families are an important source of cash. Employment with government agencies such as the Bureau of Indian Affairs (BIA) and the Public Health Service, trading posts, and tribal agencies also provides sources of income in the Tuba City area. Of the estimated 20,750 families on the reservation, 19,000 have incomes of less than $3,000/year (F. Cooper, personal communication). There is an indeterminant but significant segment of the population that has no obvious source of income. A common misconception is that there is a distribution of tribal monies among the Navajo as there is in some of the smaller Indian tribes.

Some families receive surplus food commodities as part of the Department of Agriculture's surplus food program to help those in need. Powdered skim milk, however, is usually the only milk available for infant feeding. Even its supply is sporadic and depends on conditions that determine whether skim milk is in surplus or not.

Fomon (9) and others have shown that when skim milk is given as the sole source of nutrients to an infant under 1 year of age the calorie requirement of the infant will not be met. Therefore, this deficit in calories has to be made up by giving solid foods of high calorie density. This requires a more sophisticated knowledge of nutrition than most Navajo mothers have.

Corn meal–soy flour–dried skim milk (CSM) is, on the other hand, a suitable weaning supplement that has been developed by the Department of Agriculture. It has been used successfully in treating preschool children with protein and calorie malnutrition recently in Biafra and in Manila in the Philippines (D. B. Jelliffe and R. W. Engel, unpublished observations). This product is not routinely included in the Department of Agriculture's surplus commodities program. We believe that it could and should be included and would be a useful adjunct. The use of any breast-milk substitute or weaning supplement, however, will require an associated ongoing program of nutrition education. (As of November 1968, evaporated milk, two 13-oz cans/child per month, has been included in the commodities.)

Most of the Navajo mothers purchase evaporated milk from the trading posts. There are usually no facilities for refrigeration in the Navajo homes or hogans. The formula they prepare to feed their infants after weaning is usually overdiluted and contaminated. The result is calorie malnutrition and repeated episodes of gastroenteritis. Our data show that calorie malnutrition is a greater problem than protein malnutrition. There were twice as many cases, and seven times as many deaths, from marasmus, as there were from kwashiorkor. Indeed, we may be dealing with the same phenomenon of weaning, followed by calorie and protein deficiencies and repeated episodes of gastroenteritis, occurring at different ages. In the case of marasmus it occurs early in the 1st year of life. In the case of kwashiorkor it occurs later in the 1st year, or shortly after the child has reached his 1st birthday.

Recently Winick (10) has shown that infants who die of marasmus during the first 6 months of life have fewer brain cells than well-nourished infants who die accidentally. The implications with regard to growth and the physical and mental development of Navajo children should be obvious. Top priority in any applied nutrition program on the reservation should be given to preventing calorie and protein malnutrition during the first 2 years of life.

Our data on heights and weights of 944 Navajo Head Start children taken randomly from all parts of the reservation show that the problem of growth retardation is widespread. Approximately 35% of the children had weights below the 25th percentile, and 65% had heights below the 25th percentile. This discrepancy in deficits in weight and height is probably due to the fact that by the time the children reach school age, they are beginning to catch up in weight but not in height. According to Sievers' ((7) and unpublished observations), there is a low prevalence of infection with intestinal parasites. This is probably because of the semidesert soil conditions. We feel, therefore, that the growth retardation is the end result of chronic calorie and protein malnutrition, and repeated bacterial and viral infections.

There is some evidence, however, that the severe deficiency syndromes, marasmus and kwashiorkor, are only seen in the western half of the reservation. They are not seen with any frequency in the hospitals on the eastern portion of the reser-

vation. In the eastern portion, near the Window Rock headquarters, there are industry and other tribal enterprises such as the sawmills. Thomas Welty (unpublished report), taking part in the University of Pittsburgh School of Medicine project, conducted a health survey of Sawmill, Arizona, during the months of July and August, 1967. Sawmill is in the eastern half of the reservation. He found that the heights and weights of Sawmill Navajo children were markedly less than those of equal-age children in the Boston and Iowa growth studies. Fourteen percent of the Navajo were below the 3rd percentile in weight and 26% below the 3rd percentile in height. Signs of frank nutritional deficiency disease, i.e., severe anemia, protruberant abdomen, and edema were not demonstrated. More children 0–4½ years of age were below the 3rd percentile in height and weight than were children 5–14 years of age. The older children were possibly better nourished because of the school feeding program.

Maxwell Plesset (unpublished report), also taking part in the University of Pittsburgh School of Medicine project in the summer of 1968, examined Navajo children in the Fort Defiance area. A total of 536 children was measured: 183 preschoolers, 183 beginners, and 170 second graders. He found no indication that second-grade children caught up to the Iowa-Boston norms after 2 years of adequate dietary intake and regular health care, while living in the boarding schools of the Bureau of Indian Affairs. His data showed that a high proportion of Navajo children fell into the lower percentile categories for Iowa City children. Totals of 88% of the preschoolers, 92% of the beginners, and 91% of the second-graders were below the 50th percentile in height, and 81, 80, and 82%, respectively, were below the 50th percentile for weight. The data gathered by these two medical students, therefore, are similar to ours.

One question that invariably comes up is whether it is valid to compare heights and weights of Navajo children with those of United States Caucasian children. The data recently summarized by Guzman (11) show that this is a valid comparison. The genetic differences in growth and development are far outweighed by the socioeconomic differences. Privileged children from the upper classes from many different developing countries and different ethnic groups grow nearly the same as privileged children in Boston and Iowa. They grow along a curve that is above the 16th percentile for weight and the 17th percentile for height. The data presented and reviewed in this paper suggest that the growth curve for Navajo children runs below these levels and is similar to the growth curves of underprivileged children in developing countries.

SUMMARY

The hospital charts of children, under 5 years of age, admitted with malnutrition to the Public Health Service Indian Hospital in Tuba City, Arizona, were reviewed for the 5-year period of 1963–1967 inclusive. There were 616 children with diagnoses of malnutrition. Five hundred and eighty-seven had heights and weights below the norms for their chronological ages. Fifteen had kwashiorkor and 29 had marasmus. Total serum protein and serum albumin were reduced in the cases of kwashiorkor. The occurrence of these calorie- and protein-deficiency diseases constitute a major public health problem on the western half of the Navajo Reservation.

The heights and weights of Head Start children, from all over the reservation, were below the Iowa–Boston norms. This is probably the end result of chronic calorie and protein malnutrition acting in synergism with repeated bacterial and viral infections, causing repeated episodes of gastroenteritis and respiratory infections

and contributing to increased infant mortality.

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