Health of Papago Indian Children

MORTON S. ADAMS, M.D., KENNETH S. BROWN, M.D., BARBARA Y. IBA, R.N., B.S., and JERRY D. NISWANDER, D.D.S.

THE HEALTH of the American Indian is a matter of increasing concern. Considerable evidence supports the impression that health-related problems are contributing significantly to the Indians' prolonged dependency upon government services. Knowledge of developmental and disease patterns of American Indian children is basic to the understanding of their medical needs. Several studies based on a review of the birth records of all American Indian infants born in Public Health Service facilities have documented various aspects of the disease and development patterns of the newborn (*1–5*).

This study was designed to follow up the results of examinations of newborns and obtain information on genetic and environmental factors which may be important contributors to the mortality and morbidity experienced by Indian children. In view of the approximately 10,000 Indian births each year and the wide dispersion of the various hospitals, only a selected group could be examined in the detail desired.

The Papago tribe was chosen for several reasons. Their uniform socioeconomic conditions, preservation of traditional culture patterns, and a relative absence of the confounding influence of miscegenation were each important considerations. Moreover, the availability of extensive records of lineage made possible additional genetic studies which would have been impossible in any other group (*6–8*).

Three major concerns influenced the collection of data on the Papago: (*a*) the health status of infants from birth to 1 year of age, (*b*) the health status of school children, and (*c*) the health consequences of their culture and family structure.

The Papago

The main Papago reservation occupies 2,774,000 acres of semiarid desert in southwestern Arizona along the Mexican border. This region represents the ancestral homeland of the Papago and attained official reservation status in 1916. The reservation is divided into nine political districts (fig. 1). The San Xavier Reservation which occupies 29,700 acres (with one major village) comprises district 10. Geologic formations, which traditionally limited intermarriage to some extent, define these districts (*7*). Thus, the members of each district are bound by biological as well as cultural ties. Approximately 40 villages (10 of them with more than 100 residents each) established along fam-

Dr. Adams is assistant professor of genetics and pediatrics, division of genetics, University of Rochester School of Medicine and Dentistry, Rochester, N.Y. Dr. Brown, Mrs. Iba, and Dr. Niswander are with the Human Genetics Branch, National Institute of Dental Research, Public Health Service.

Miss Lillian Watson, public health nurse supervisor, Indian Health Service, Sells, Ariz., and her staff, including the translator assistants—Mrs. Philipa Lewis, Mrs. Blanche Hendricks, and Mrs. Catherine Norris—aided in conducting the family interviews. Mrs. Aline Pournelle, health records librarian at the Sells hospital, assisted in the compilation of data from the hospital records.

ily lines are distributed throughout the main reservation (*9*).

The infants and children examined in this study are among the 5,000 to 7,000 Papago who live on the two reservations (table 1). The total population of the Papago tribe approaches 12,000. There is considerable mobility between the reservations and between on-reservation and off-reservation residences. The largest village is Sells. It is the site of the Public Health Service Indian Hospital, Bureau of Indian Affairs compound, and the tribal administrative offices. It has grown steadily in the last three decades (*7*).

Health facilities provided include a 50-bed general hospital staffed by four physicians and a dentist. A health center is located in district 3 (Gu Achi) at Santa Rosa, the second largest village on the reservation. It is staffed by a physician who also attends biweekly clinics at Pisinimo in district 6. A clinic with a staff physician is also located at San Xavier. Four to five public health nurses are assigned by area to the entire reservation and make regular visits to each village. Residents of the northern part of the reservation also use the Public Health Service Hospital at Sacaton on the Gila River Reservation.

Birth to 1 Year of Age

One hundred and twenty-seven full-blooded Papago infants living on the two reservations were born in the Sells hospital from July 1965 through December 1967 and seven were born at the Sacaton hospital from May 1966 through December 1967 (table 2). During visits to 134 families, 124 examinations of infants (57 boys,

Figure 1. Political districts on the Papago reservations and principal villages with schools and medical facilities

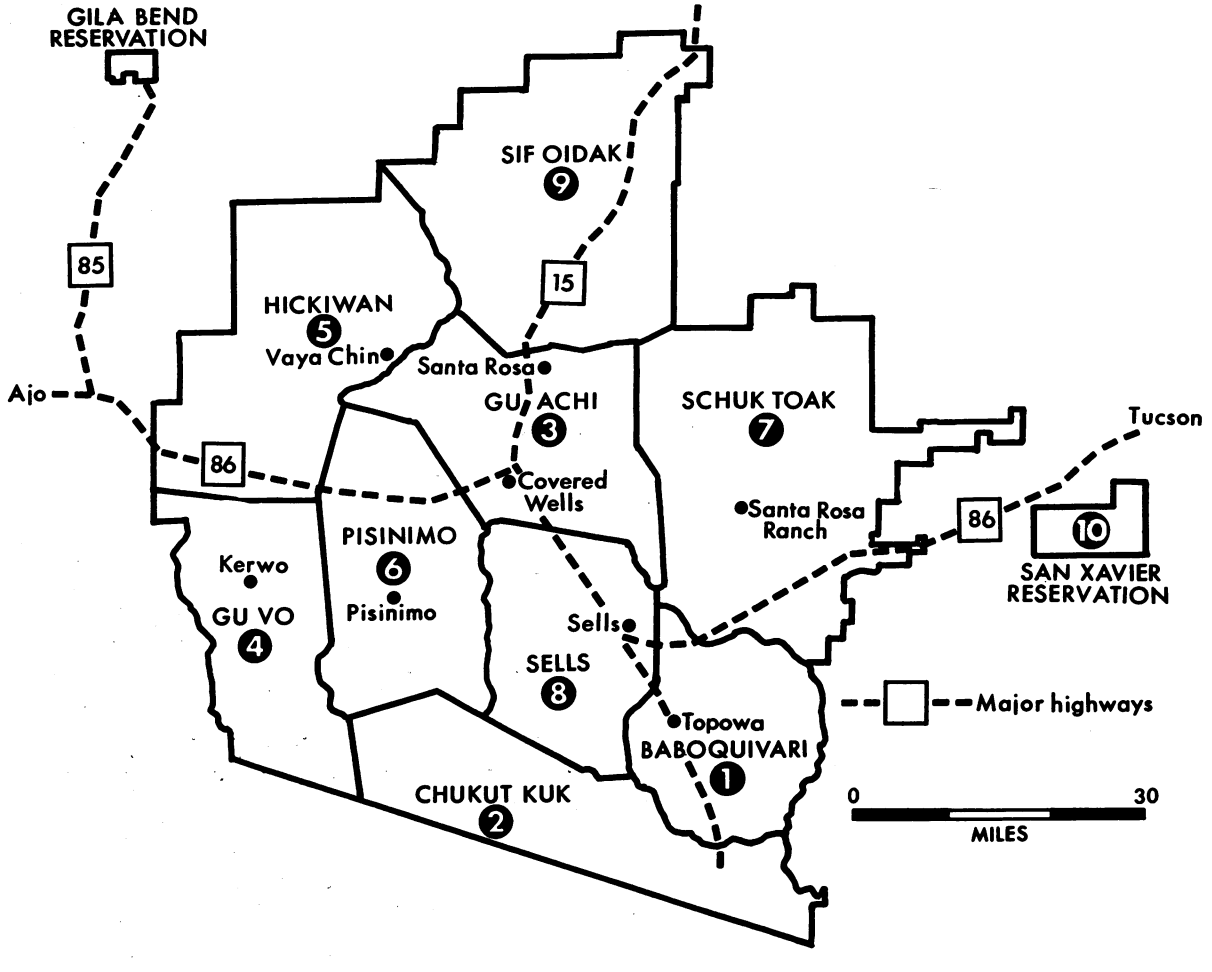


Table 1. Papago Reservation districts with approximate population in December 1967 and number of births of full-blooded Papago at Sells and Sacaton hospitals, July 1965—December 1967

District and No.	Population	Families	Births
1. Baboquivari	627	136	17
2. Chukut Kuk	126	27	8
3. Gu Achi	538	128	15
4. Gu Vo	287	64	6
5. Hickiwan	355	77	9
6. Pisinimo	401	94	2
7. Schuk Toak	293	64	12
8. Sells	1, 349	266	46
9. Sif Oidak	598	116	15
10. San Xavier	560	115	4
Total	5, 134	1, 087	134

SOURCE: Demographic and socio cultural characteristics: Papago Indian Reservations, Arizona. Health Program Systems Center, Division of Indian Health, Public Health Service, September 1968.

67 girls) were completed. Not examined were two stillborn infants (one boy and one girl), four boys who died in the neonatal period, and three boys and one girl who had been adopted or whose families had moved. There was one set of twins in the group of 134 children. The girl was examined; her twin brother had died 12 hours after birth.

Examinations of the infants at about 1 year of age were made during four field trips in 1967 and 1968. The examinations were done in the infant's home and consisted of the "One-Year Neurological Examination" used by the collaborative research study of the Perinatal Research Branch, National Institute of Neurological Disease and Blindness. This protocol includes a full general physical examination. Findings on the 1-year examination indicated that most of the major congenital malformations as defined by Neel (*10*), with the exception of some heart defects, were detected at birth and reported on the infants' records.

At the same home visit, a blood sample was drawn from the mother 1 hour following ingestion of 75 grams of glucose. The height and weight of the mother was also measured.

Records of all of the 128 living infants were examined at the Sells hospital. Records of the infants who had outpatient care at the Santa Rosa clinic were also examined. Of the 128, four who were living on the San Xavier Reservation and one whose adoptive residence was unknown had no outpatient records available. These charts were reviewed for data on well-baby care, episodes of diarrhea, respiratory disease, and other illness, and for measurements of growth.

Birth weight. The mean birth weight of the 133 infants whose families were visited (excluding the twins) was 116.94 ounces. After eliminating the two stillbirths and six infants with malformations, the mean birth weight for 125 infants was 118.03 ounces (65 females—117.52 ounces, 60 males—118.58 ounces). The birth

Table 2. Ascertainment of families selected for visits in 1967–68

Place and period of birth	All births in hospital	Fullblooded Papago infants				
		Total	When examined	Number examined	Stillbirth	Neonatal death	Not living with mother
Sells hospital							
July 1965–March 1966	98	45	January–February 1967.	42	1	0	2
April–June 1966	41	13	May–June 1967	12	0	1	0
July–December 1966	88	45	November 1967	41	1	2	1
January–December 1967	172	24	May 1968	23	0	1	0
Sacaton hospital							
May 1966–December 1967	392	7	May 1968	6	0	0	1
Total	[1] 791	134		124	2	5	4

[1] Includes births of 263 non-Papago infants, 197 non-fullblooded Papago infants, and 197 fullblooded Papago infants whose parents lived off the reservation. None of these infants was examined.

weight of Papago infants was examined for heterogeneity among reservation districts and none was found.

The mean birth weights for the Papago and other southwestern tribes shown in table 3 are for single, liveborn, nonmalformed infants taken from all Public Health Service Indian hospital birth records from July 1964 through June 1968. These data include non-fullblooded Papago living off the Papago and San Xavier Indian Reservations so that they compare with the information on the other tribes. The mean birth weight of the Papago is similar to that of the Pima but averages about 2 ounces lighter for both sexes. These two tribes appear to have heavier birth weights for both sexes than most other southwestern Indians except the Mohave.

The birth weight of the liveborn Papago infant is significantly affected by the status of the mother in regard to diabetes (table 4). Among mothers with plasma glucose below 150 mg. per 100 ml. 1 hour following a 75-gram glucose load, the average weight of the offspring was 117.6 ounces, while the offspring of mothers with plasma glucose of 150 mg. per 100 ml. or more had an average weight of 128.0 ounces.

Growth. The growth in weight of Papago infants during their first year of life is presented in figure 2. This study is longitudinal and, although a weight is not available for each infant every month, three-fifths of the infants were weighed in any given month. No infant had less than six recorded weights and most had between 8 and 10.

There is an indication that for the first 6 to 8 months these infants follow substantially the same growth curve as white infants. Papago boys are perhaps somewhat larger. However, this advantage is lost before the end of the first year and infant girls actually fall substantially behind the white children. This dip in the growth curve may represent the burden of greater infectious disease among the Papago. To study this possibility, children who had been hospitalized were separated from those who had escaped hospitalization prior to each monthly interval. Following hospitalization the child was not returned to the "healthy" group even though he fully recovered. When these data were plotted, no change in the pattern of growth was observed, although the hospitalized children

Table 4. Distribution of birth weights of 94 Papago infants, by maternal blood glucose levels

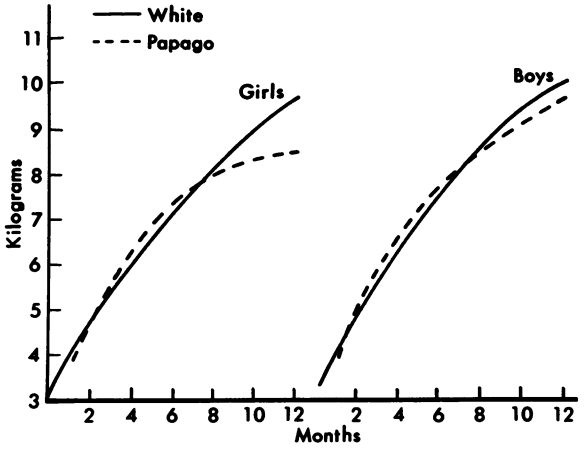
Birth weights of infant (ounces)	Mothers with glucose levels—	
	Less than 150 mg. per 100 ml.	150 mg. per 100 ml. or higher
Less than 88	5	2
88–103	10	1
104–119	35	3
120–135	22	5
136–151	7	3
152–167	0	1
Total	79	15
Average glucose level mg. per 100 ml	111	192
Average birth weight (ounces) [1]	117.6	[2] 128.0

[1] Excludes stillbirths and premature births.
[2] Significantly different at 5 percent confidence level.

Table 3. Birth weights of single, live, nonmalformed infants of eight southwestern Indian tribes, July 1964–June 1968

Tribe	Males		Females		Total	
	Mean weight (ounces)	Number	Mean weight (ounces)	Number	Mean weight (ounces)	Number
Apache	113.04	906	111.26	845	112.18	1,751
Hopi	113.26	277	110.66	280	111.97	557
Mohave	129.40	50	119.43	45	124.59	95
Navajo	114.80	5,416	111.82	5,316	113.33	10,732
Papago	120.78	388	115.15	404	117.88	792
Pima	122.08	280	118.23	264	120.13	544
Pueblo	115.27	252	110.67	273	112.90	525
Zuni	114.10	376	109.83	325	112.15	701

Figure 2. Growth of Papago infants during the first year of life compared to normal white infants



SOURCE: reference 12

were consistently lighter than their healthy peers.

Mortality. Mortality in this group of infants was 5 percent. There were two stillborn children. One was the child of a 38-year-old, diabetic, gravida 8 mother. The other infant was born at term weighing 5 lbs., 4 oz. and had severe phocomelia of all extremities. The five neonatal deaths included one premature boy (birth weight 2 lbs., 10 oz.) who was normal except for a supernumerary digit. Death was apparently due to immaturity. A second child who died 1 hour after birth had multiple malformations including congenital heart disease, low-set ears, and clubfeet. The pregnancy was complicated by polyhydramnios. The third neonatal death occurred in a 2-week-old boy. Prior to delivery his mother was febrile and there was evidence of fetal distress. He was treated with antibiotics but his illness followed a septic course. Autopsy revealed no malformations. The fourth neonatal death was due to pneumonia following prolonged rupture of membranes. He died during transfer to the hospital in Phoenix, Ariz., at 11 hours of age. The final neonatal death was that of a 3 lb., 4 oz. boy. He was the smaller of twins and died at 12 hours of age with respiratory distress. No autopsy was performed.

Morbidity. More than half the infants were hospitalized during their first year. There were two frequent causes of hospitalization—gastrointestinal illness, mostly bacterial diarrhea, and respiratory illness such as tracheobronchitis and pneumonia. These account for most of the hospitalizations and the bulk of hospital days (table 5). The average duration of hospitalization for each category of illness was about 16 days, but some children had hospitalizations for several types of illness; the average total inpatient time for this group of patients is 24.5 days. Included in the other category of diagnoses were two children with failure to thrive as a result of malnutrition and neglect who had prolonged hospital stays. Cases of meningitis, measles, suspected tuberculosis, dilation of postoperative anal atresia, kerosene ingestion, omphalitis, otitis media, and milk allergy were also in the other category.

The pattern of outpatient visits was similar (table 6). These infants averaged 3.2 outpatient visits for upper respiratory infections, 1.4 visits for diarrhea, and 1.1 visits for other complaints including otitis media, conjunctivitis, dermatitis, and chickenpox. No child with pneumonia was treated on an outpatient basis.

Any assessment of morbidity among this population must be coupled with a consideration of hospital use and population distribution. From table 6 it is clear that the distribution of infants using health facilities is far from uniform over the reservation. More than half the children live within the three districts (1, 7, 8) closest to the Sells hospital. These children make more use of its facilities than those living in more remote areas. The average rate of use falls off proportionally and significantly as the travel time from the hospital increases.

The correlations of average travel time to the hospital and the rate of outpatient use are all significantly negative (table 6). This finding suggests that a major factor in use of hospital services is difficulty in getting to the clinic. The

Table 5. Hospitalizations in the first year of 67 Papago infants

Type of illness	Total days	Number of children	Average stay (days)
Gastrointestinal	669	40	16.7
Respiratory	748	49	15.3
Other	222	14	15.9
Total	1,639	67	24.5

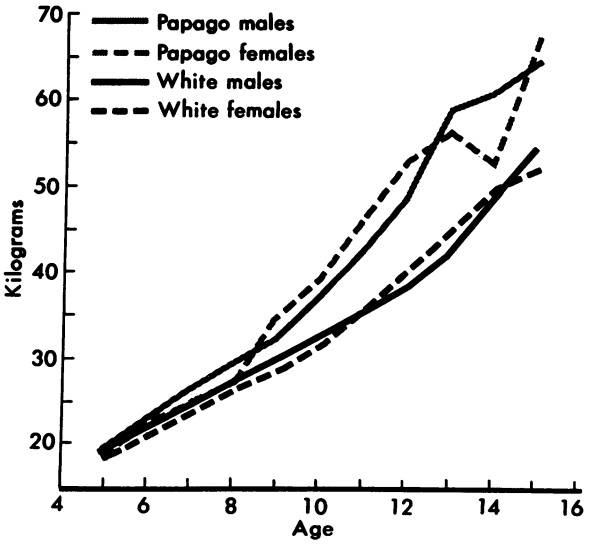
same factor does not appear to apply to hospital admissions for which there was no significant correlation between admission and district.

School Children

School children were examined at all nine schools on the reservation (fig. 1). There is a public school in Sells with classes through the ninth grade. The Federal Government maintains elementary day schools in three smaller villages (Santa Rosa Ranch, Vaya Chin, Kerwo) and a boarding school in Santa Rosa. Franciscan Fathers administer mission grade schools in four other villages (Topowa, San Xavier, Covered Wells, Pisinimo). High school education is not available on the reservation but may be obtained in Government boarding schools.

More than 900 children were weighed and measured. Visual acuity and color vision ability were tested using a vision screener equipped with Landolt ring charts for acuity testing and reproductions of Ishihara plates for color vision testing. Glucose tolerance of 292 unselected children who were 10 years of age or older was tested. Blood was drawn 1 hour after a 75-gram oral glucose load. Dr. Thomas L. Burch made the glucose determinations at the field laboratory of the National Institute of Arthritis and Metabolic Diseases in Phoenix. One hundred and ninety-three older children received dental examinations, and a random sample of 140 had impressions made for the fabrication of dental casts.

Figure 3. Growth in weight of Papago school children compared to normal white children



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Growth. The values of the mean heights and weights observed for Papago school children by age are presented in table 7 and plotted with the comparable data for white children in figures 3 and 4. Their stature is typical of similar age white children and they are somewhat taller than Navajo or Japanese children (*11–13*). Weight, however, shows a rather dramatic increase beginning at about 8 years among the girls and approximately a year later among the

Table 6. Use of outpatient clinic in the first year of 123 Papago infants, by district

District	Average travel time (minutes)	Number of children	Average outpatient visits per child for—					Average hospital admissions per child
			Well baby care	Gastro-intestinal illness	Upper respiratory illness	Other complaints	Total	
1	27	17	4.0	2.0	4.0	1.2	11.2	1.2
2	37	8	2.9	1.6	3.4	1.2	7.9	.6
3	36	14	2.7	1.6	2.6	.7	4.5	2.0
4	107	6	.2	.5	1.3	.0	2.0	1.7
5	77	9	.1	.2	1.0	.3	1.7	1.1
6	61	2	4.5	1.0	5.5	1.5	12.5	2.0
7	33	10	2.3	2.0	2.2	.8	7.3	1.4
8	21	43	3.6	1.6	4.4	1.5	11.1	1.3
9	75	14	1.7	.8	1.3	.6	4.4	.4
Total		123	2.8	1.4	3.2	1.1	8.5	
Correlation of usage rate and travel time			−.73	−.89	−.58	−.75	−.67	+.03

Table 7. Anthropometric measurements of 929 Papago school children

Age (years)	Stature (cm.)			Weight (kg.)		
	Number	Mean	Standard deviation	Number	Mean	Standard deviation
	Males					
5	18	100. 33	4. 82	18	19. 20	2. 11
6	40	115. 13	11. 55	40	22. 53	3. 64
7	58	122. 93	6. 14	57	26. 19	7. 15
8	73	130. 05	5. 93	73	29. 58	7. 24
9	50	134. 05	6. 26	49	32. 67	7. 61
10	55	138. 49	6. 09	55	37. 04	9. 87
11	57	147. 12	7. 79	57	42. 61	12. 98
12	47	153. 32	7. 19	47	48. 44	12. 09
13	41	159. 38	6. 29	41	58. 42	14. 68
14	21	164. 77	7. 68	21	60. 66	17. 70
15	9	165. 10	6. 62	9	64. 30	15. 02
	Females					
5	17	109. 56	4. 14	17	18. 85	2. 08
6	50	117. 15	5. 01	52	22. 09	3. 03
7	70	121. 26	5. 71	71	24. 75	4. 31
8	47	126. 23	5. 35	47	27. 12	5. 94
9	58	136. 05	8. 17	58	34. 89	9. 12
10	50	141. 45	8. 43	50	39. 16	9. 12
11	44	146. 96	5. 56	43	46. 04	12. 11
12	38	153. 56	3. 74	37	53. 54	21. 33
13	52	152. 77	7. 41	52	56. 02	13. 69
14	24	155. 12	4. 19	24	52. 94	10. 94
15	10	158. 10	4. 39	10	71. 42	10. 24

boys. Some measure of ponderosity was therefore necessary to document this growth pattern.

The mean ponderal index

$$\left(PI=3\sqrt{\frac{\text{ht.(cm.)}}{\text{wt.(kg.)}}}\right)$$

of the Papago children and comparative data on white children are presented in figure 5. The mean PI of Papago boys remained stable between 41 and 43 from age 6 to 15 years. Papago girls show a decreasing PI after age 9, falling from 42.1 to 38.1 by age 15. These PI patterns are very different from those of white children who show a steady increase in PI of a similar type for both sexes from age 5 to 12. White children of both sexes have higher ponderal indexes than do Papago at all ages, and the difference between the two populations increases with age up to 14 years. These differences in PI are almost entirely a reflection of increased weight among the Papago rather than lack of growth in stature, since until age 14 the Papago children match the stature of white children of the same age. The ponderal index continues to drop in the Papago children to adult values of 38.9 for men and 37.1 for women. The adult Papago values are from a sample of 33 men from ages 24 to 77 and 107 women from ages 18 to 68.

Health. Table 8 shows the results of the glucose tolerance tests for 137 boys and 155 girls. There was no appreciable difference in glucose tolerance between boys and girls and no trend with age. There were two boys with blood sugars above 210 mg. per 100 ml., a 13-year-old with a blood sugar of 406 mg. per 100 ml. and a 15-year-old with a blood sugar of 214 mg. per 100 ml. This number is a frequency of 0.68 percent (approximately 1 in 150). The overall frequency of blood sugar levels of 150 mg. or more was 2.4 percent.

Table 9 summarizes the data on visual acuity obtained using a Landolt ring test for far vision in a sample of 323 Papago children and adults. The distribution of visual acuity differed between the old and the young and between the sexes at younger ages. Among those more than 45 years old the sex difference was not present. More than half of the older group had visual acuity of 20/40 or less, and only three of 42 had acuity of 20/17 or better. In the age range 30 to 44 years more than half had acuity

of 20/22 or better. Among those under age 30 a difference between the sexes was apparent. Males had better acuity than females. Females were much more prone to have acuity of 20/40 or less while males were more likely to have acuity of 20/17 or better. Sixty-three percent of boys under 15 had acuity of 20/22 or better while only 45 percent of girls were in the same range. More than 37 percent of girls age 10 to 15 had acuity of 20/40 or less while only 12 percent of the boys are in this range.

The significance of these results of acuity tests is not clear. Several factors are involved in the interpretation of the records. Myopia does occur and was observed in 12 of the persons scoring 20/40 or less. Endemic trachoma is a major medical problem of the Papago and accounts for much of the reduced visual acuity among the adults. Active programs of prevention and therapy may account for much of the difference between younger and older groups.

The primary concern of the dental studies was the evaluation of tooth alignment and other morphological variations of dentition. An almost constant finding in the dentition of the 193 children examined was the presence of

Figure 4. Growth in height of Papago school children compared to normal white children

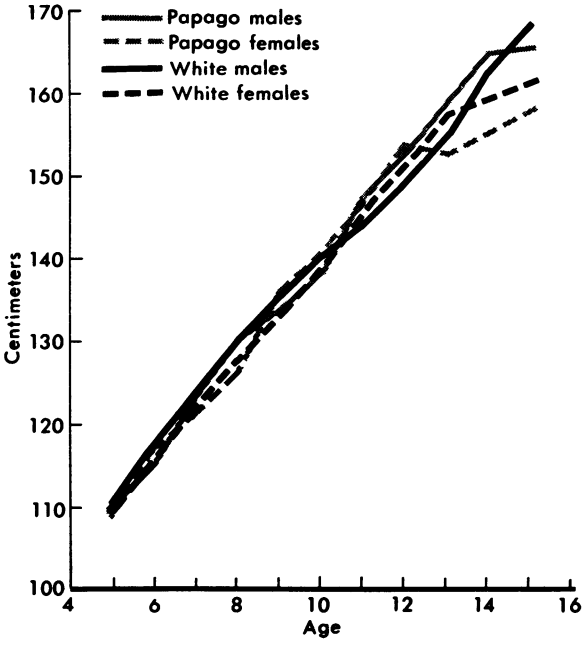

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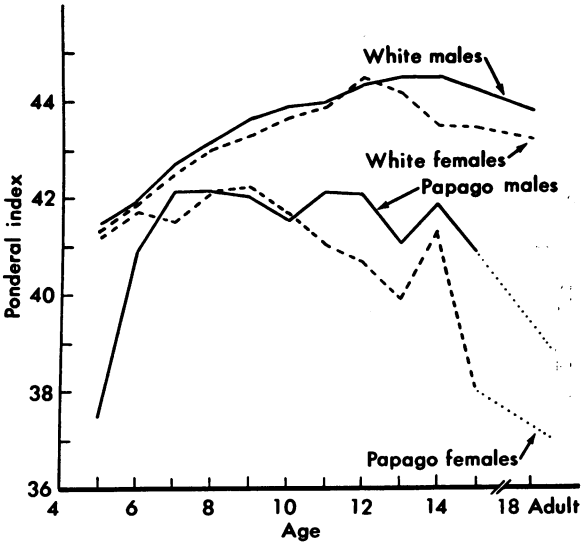
Figure 5. Ponderal index of school-age Papago and white children



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shovel-shaped incisors, a trait characteristic of Mongoloid populations. These teeth have thickened marginal ridges on their lingual surface, giving the incisor crowns a definite shovel-like appearance. It was observed in a moderate to marked degree in 94 percent of the group. This trait is of little clinical significance except that in some persons it appears to contribute to malalignment of the upper incisors.

A relatively common variation in upper lateral incisor morphology found among many Indian groups, a barrel-shaped incisor, was encountered in 7 percent of the children. This variation may represent an extreme form of the shovel-shape trait and is of significance in that a deep lingual pit particularly susceptible to the initiation of dental caries is often present. Caries forming in such a pit may extend to the pulp of the tooth and result in a periapical abscess with practically no evidence of a lesion on the surface of the tooth.

Malocclusion was assessed using Angle's classification of anterior-posterior jaw relationship (*14*). Frequencies of the four major categories were as follows: no significant malocclusion, 33 percent; class I malocclusion, 48 percent; class II malocclusion, 14 percent; and class III malocculsion, 5 percent. Comparable figures in an earlier study of Japanese children using similar criteria were normal occlusion,

41 percent; class I, 44 percent; class II, 12 percent; and class III, 3 percent (*15*). For white school children residing in Utah the frequencies were normal occlusion, 36 percent; class I, 30 percent; class II, 24 percent; and class III, 10 percent (Niswander, unpublished data).

In general, the dental status of the Papago children is characterized by low caries rates, moderate to severe fluorosis, moderate abrasion, and relatively poor oral hygiene with an accompanying high prevalence of gingivitis. One 12-year-old girl with multiple papules of the oral mucosa was observed. The lesions were similar in appearance to those of focal epithelial hyperplasia previously described (*16*, *17*). Focal epithelial hyperplasia of the oral mucosa is unusual because it is apparently restricted to Indians. More than 40 cases have been observed in young Indians of North, Central, and South America, but none have been reported in whites or Negroes. The clinical and histological characteristics of the lesions suggest a viral etiology. The papules and nodules can be extensive throughout the buccal and lingual mucosa and may present a rather dramatic picture if traumatized or seen with superimposed herpetic ulcerations.

Table 8. Blood sugar levels of 292 Papago school children following a 1-hour glucose tolerance test

Age (years)	Number	Mean level (mg. per 100 ml.)	Standard deviation
Boys	137		
10	13	103.7	15.61
11	36	102.4	17.10
12	30	93.4	21.64
13	35	99.4	16.67
14	17	95.6	12.21
15	6	93.0	22.61
Girls	155		
10	12	108.6	18.40
11	29	96.1	29.95
12	41	99.1	20.07
13	46	101.7	20.03
14	20	96.9	15.15
15	7	112.5	20.41

Table 9. Visual acuity of 323 Papagos, by age and sex

Visual acuity and sex	10–15 years	16–29 years	30–44 years	45 years or older	Total
20/40 or less:					
Male	8	7	9	12	36
Female	30	13	11	13	67
20/35 to 20/25:					
Male	17	5	4	4	30
Female	14	10	5	4	33
20/22 to 20/18:					
Male	24	5	4	2	35
Female	23	9	7	4	43
20/17 or better:					
Male	19	13	10	2	44
Female	13	10	11	1	35
All males	68	30	27	20	145
All females	80	42	34	22	178

Consequences of Cultural Patterns

Congenital defects. Congenital malformations among American Indians have been reported from a review of records of newborns (*4*). American Indians as a whole have a total frequency of major congenital defects similar to other major racial groups, although they differ in the frequency of specific defects. From our study it became evident that the distribution of specific major malformations in subsets of the population is not uniform. Certain malformations did not occur at all in the Papago in the period studied, whereas myelodysplasia and microphthalmia occurred with extremely high frequency.

The diagnosis of myelodysplasia, including both spina bifida and anencephaly, is easily and accurately made. Review of the records of the Sells Indian Hospital and the Phoenix Area Indian Hospital, which is the center for medical care for the entire area, led to the ascertainment of seven cases of myelodysplasia in Papagos. Extended pedigrees were drawn for each case and juxtaposed with sections of a map of the reservation to reveal the mating patterns of families which produced affected persons. Two main clusters and one sporadic case were identified (fig. 6).

One cluster had its origin in the village of Choulic in Chukut Kuk District (district 2). This family group had three affected children, all descended from three brothers who married women from nearby villages. Two of the affected siblings were the product of a consan-

Figure 6. Areas of residence and pedigrees of Papagos with myelodysplasia

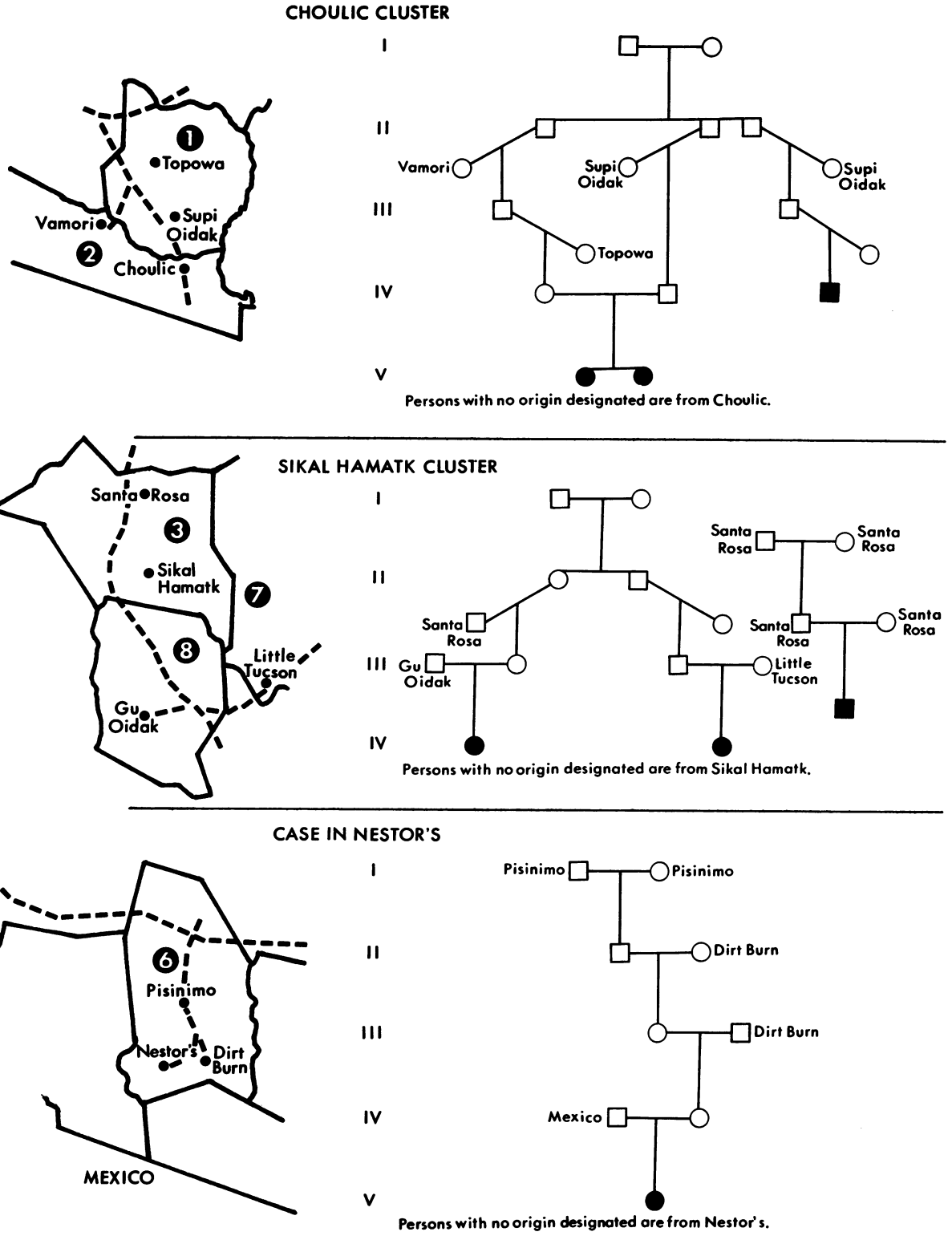
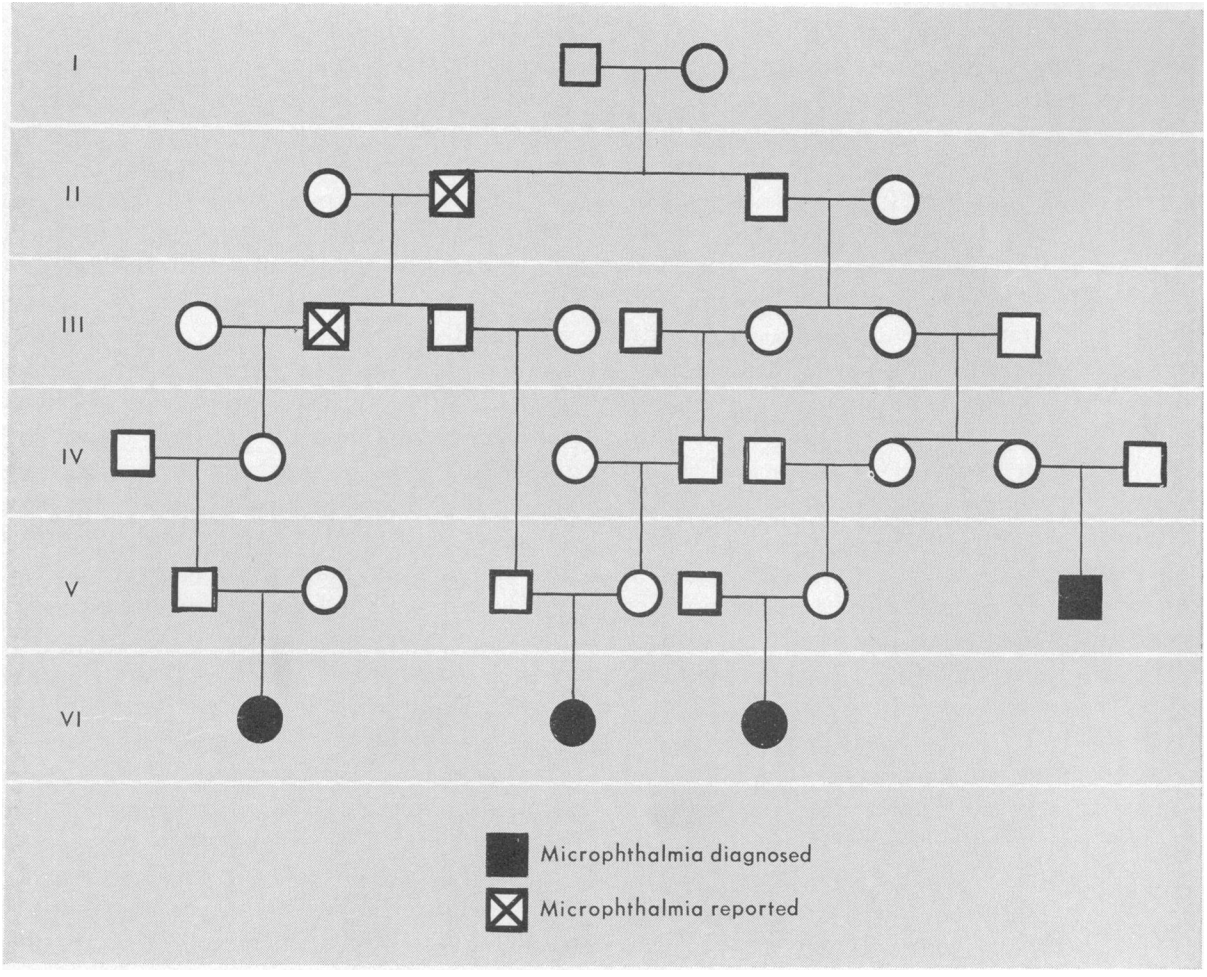


Figure 7. Pedigree of Papagos diagnosed or reported to have microphthalmia



guineous mating between first cousins once removed ($F=1/32$).

The second cluster originated in the village of Sikal Hamatk in Gu Achi District (district 3) and resulted in two propositi and a third affected person from the same district who can be tentatively linked with this cluster. The isolated case occurred in Nestor's in the Pisinimo District (district 6), and all blood relatives except the father were from this district. There is no evidence for the last five generations that the Choulic and Sikal Hamatk groups have shared genetic material, and they probably have been isolated for much longer.

A rare malformation, microphthalmia, occurred in a cluster in Sif Oidak District (district 9). Four cases were diagnosed by ophthalmologists at the Phoenix Indian hospital. Anecdotal reports of two affected antecedents are available. An extensive pedigree of this group was constructed (fig. 7), and the four affected persons (V, 7; VI, 1–3) almost certainly all descended from brothers (II, 2, 3) both of whom lived in the village of Cockleburr. All relatives of the four persons with microphthalmia come from Cockleburr or the neighboring village of Chui Chu. No other cases of microphthalmia are known among the Papago.

Discussion

Evaluation of the health of American Indians (in this paper, Papago children) necessarily leads to comparison with populations which differ genetically (racially) and culturally and which live in vastly different environments. Each of these factors affects health parameters. There are well-recognized differences between

races for the anthropometric measurements used to evaluate growth. Diet and disease also affect normal growth, and both are intimately related to culture and environment. This complex interplay is part of the process recognized as adaptation.

The Papago and Pima newborns are generally heavier than other southwestern Indians. The differences in birth weight may reflect differences in body structure and metabolism. The Pima and Papago have relatively high frequencies of diabetes, which is associated with increased birth weight. However, the relation to diabetes is probably not a major factor in these tribal differences because the Hopi and Zuni also have high frequencies of diabetes but low mean birth weights (*18*).

The growth pattern of Papago children during the first year of life was consistent with many other reports of children living under substandard nutritional and health conditions. This pattern characteristically shows children of all races and conditions paralleling each other for the first 6 months. Thereafter the disadvantaged infant shows a marked falling off of his growth rate. Salber (*19*) has reported this phenomenon for South African infants, as have Parsons (*20*) for Australian aborigines and Su and Liang (*21*) for Chinese. Meredith's (*22*) review of the first postnatal year of North American Negro infants compared with white babies revealed that although the Negro baby was somewhat lighter throughout the period, he did not show the decreased rate of gain during the second half of the first year if he was well cared for. Comparable data are not available for American Indian infants. However, it is possible that the growth pattern we observed in the first year reflects malnutrition to a greater degree than genetic differences.

Infectious diseases, especially diarrhea and pneumonia, present the greatest health problem of Papago children during the neonatal period and through the first year. It is unlikely that these children have a peculiar susceptibility to these disorders (*23*).

However, the impact of infectious disease is certainly affected by cultural and environmental factors. During the hot summer months, diarrhea becomes a serious problem as the opportunity for transmission of infective agents increases. Because the Papago frequently do not have refrigerators it is impossible to keep artificial formulas sterile. Water is hauled considerable distances in unsanitary containers and is stored in open vats and pots.

The infant is the one most seriously affected by diarrhea and, too often, the parents do not get him to the hospital until the infection is considerably advanced. Although treatment with intravenous fluids is usually successful, it has been suggested that such febrile illnesses associated with extreme dehydration may cause irreversible changes in perceptual and mental abilities. Hospitalization for diarrhea is usually prolonged (an average of 16.7 days), since staff physicians have learned that recurrences are frequent if the child is returned to the home environment before he has completely recovered and shown a significant weight gain.

Breast feeding and closer medical supervision would greatly reduce the morbidity from diarrhea. Unfortunately, breast feeding frequently is not possible with Papago mothers. Children are often placed in the care of babysitters or grandparents while the mother is working or otherwise occupied. The long distances which separate most villages make intensified medical supervision difficult. The possibility remains that an intensive program especially aimed at reducing mortality and morbidity resulting from diarrhea might well be an entering wedge toward controlling the health problems of the Papago.

Pneumonia in the Papago children is also seasonal and is apparently due to secondary bacterial invasion in infants predisposed by viral infections of the upper respiratory tract. These infections are extremely common during the colder months when the family is confined to close quarters and viral infections are common. Physical or X-ray evidence of pneumonia uniformly warrants hospitalization since treatment and diet can be more closely supervised.

Hospital use varies due to transportation problems. Families from outlying districts in particular find it difficult to travel to the Sells hospital. For example, two children have died from neonatal tetanus since this study was completed. Neither was born in the hospital, although the mothers had tried to obtain transportation. These deaths have led to a policy of

immunizing mothers during the prenatal period. However, the basic difficulty of delivery of health services on the reservation remains unsolved.

The differences in correlation of the various types of outpatient visits to distance of residence from the hospital show that cultural factors as well as simple distance are involved. Well-baby visits, which are prearranged, and visits for respiratory illness, which is recognized as serious by the mother, have lower correlations to distance than do visits for diarrhea, which is considered an Indian disease. This lower correlation may reflect the mother's recognition of the seriousness of different types of illness or her acceptance of hospital services for certain types of illness.

The lack of correlation between inpatient admissions and distance of residence from the hospital may reflect several factors. There is actually a positive correlation of inpatient admission to distance of residence from the hospital once the child appears at the outpatient department. This situation reflects the reluctance of physicians to send a potentially ill child home if home is a long distance from the hospital, as well as the increased severity of illnesses of children who have been brought by their parents over longer distances. Both factors reflect the major effect transportation has on the medical care of Papago infants. Also, acceptance of medical care may be low among those living in the areas of the reservation most remote from the hospital, contributing to delay in seeking transportation to the hospital.

The growth of school-age Papago children is remarkable in the early onset of obesity. This phenomenon has been repeatedly observed by the medical personnel working on the reservation and is recognized by the Indians themselves as the typical growth pattern. Doubtless the Papago's high carbohydrate diet contributes to this obesity. Unfortunately, dietary manipulation is difficult for both cultural and financial reasons. The frequency of diabetes mellitus in the adult Papago is high. Among the children we tested, at least two had blood sugars, 1 hour after a glucose load, which were unequivocally in the diabetic range. Neither child experienced polyphagia nor considered himself ill. Both were obese.

Niswander has recently commented on the apparently greater prevalence of malocclusion among modern industrialized populations compared with ancient man and modern primitive groups (*24*). The reasons for this prevalence are not clear, although there is a suggestion that environmental factors play an important role, perhaps through the disruption of highly adapted oral-facial growth pattern relationships. It would be of considerable interest to know if the high prevalence of malocclusion among the present Papago children is of recent origin or characteristic of Papagos living prior to disruption of aborginal culture patterns by the white man.

To obtain information on this point we attempted to locate skeletal remains of ancestors of the present-day Papago Indians. Although a moderate amount of such skeletal material exists, most of it is not well enough preserved to allow reliable assessment of dental alignment. Dr. Charles Di Peso made available skeletal material at the Amerind Foundation, Dragoon, Ariz., and Dr. Walter Birkby assisted us in examining the skulls in the collection of the University of Arizona, Tucson.

To date only 10 skulls sufficiently intact for comparative purposes have been found. These date roughly from the period between 1300 and 1700 A.D. All showed nearly perfect occlusion. Although the sample is extremely small and there can be no absolute certainty that these persons are, in fact, direct antecedents of the present-day Papago, it suggests a striking increase in the prevalence of malocclusion among the Papago occurring sometime in the last 600 years. Such a wide timespan allows for either genetic or environmental factors to be responsible for this temporal change.

Pedigree analysis suggests that, in this population, the frequency of several congenital defects is principally consequent to the cultural factors dictating the mating pattern. Thus, nearly all cases of microphthalmia and myelodysplasia are accounted for by several small endogamous mating groups. A conservative estimate of the frequency of myelodyplasia among the Papago can be obtained for the last 5 years for which we have reasonably complete records of the number of births. During these years, births averaged approximately 200 per year,

occurring almost exclusively in the Sells (64 percent) and Sacaton (33 percent) hospitals. During this period, there were five cases of myelodysplasia, a frequency of 1 in 200 births. This exceedingly high frequency, attributable to small clusters of cases, may well account for the high frequency of this malformation in much larger Indian populations (*3*).

Microphthalmia is a heterogenous entity, and various modes of inheritance have been observed in clinically undistinguishable cases. The cluster of cases occurring in the Sif Oidak District most likely represents simple autosomal recessive inheritance. If so, the large number of cases reflects a high level of endogamy present in this group of adjacent villages.

The etiology of myelodysplasia is not as simple. It would appear that an interaction between a specific polygenic predisposition and environmental factors is important. The high frequency of diabetes mellitus (*18*) present in adult members of the tribe may be significant. It has been suggested that this disease is related to "anti-insulin" activity in the synalbumin fraction of human plasma. Elevated levels of anti-insulin have also been reported in the mothers of myelodysplastic children (*25*).

Summary

The Papago Indians reflect their genetic potential in birth weight, growth and development, and metabolic patterns. These have all been shaped by their prolonged residence in the arid southwest which has become more desert-like during the past 1,000 years. These traits seem to be shared with their linguistic and historic relatives, the Pima. The high frequency of certain malformations can be attributed to cultural patterns which were also adaptive in this environment.

The pattern of disease seen in Papago infants and children is associated with a harsh environment. Lack of water and sanitation are major components in the etiology of diarrhea, and the cold desert winter, which results in crowding into largely unheated houses, contributes to the burden of pneumonia and respiratory disease. A major limitation on the use of hospital services appears to be isolation by distance. These conditions are preventable.

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Tearsheet Requests

Morton S. Adams, M.D., University of Rochester School of Medicine and Dentistry, 260 Crittenden Blvd., Rochester, N.Y. 14620

Head Start Progress Report

Thousands of disadvantaged preschool children are receiving medical and dental services, as well as immunizations, for the first time through Project Head Start. In fiscal year 1969, some 447,000 children were enrolled in Head Start summer programs and 217,000 in full-year programs, according to the Office of Child Development.

The following table shows Project Head Start's 1969 medical and dental information, in percentages, according to the children's parents:

Status	*Full-year*	*Summer*
Condition found:		
Yes	41. 9	39. 7
No	49. 9	49. 8
Not examined	3. 2	4. 1
Unknown	4. 9	6. 4
Treatment received:		
Yes	88. 1	80. 0
No	9. 7	16. 8
Unknown	2. 1	2. 5

Estimated figures show that before being enrolled in Head Start during 1969, 37,975 children participating in the full-year programs and 84,483 in the summer programs had received complete immunization for DTP, poliomyelitis, smallpox, and measles. During 1969, Head Start obtained immunizations for approximately 43,183 additional children in the full-year programs and 34,419 in the summer programs.

The urgent health needs of Head Start youngsters are indicated by the following data from 1968 reports:

- 1.9 percent of the children in full-year programs and 2.2 percent in summer programs had positive reactions to tuberculin testing.
- Of the children tested for anemia, 15 percent of those in full-year programs and 11 percent in the summer programs were found to be anemic.
- Of the children given screening tests for hearing abnormalities, 4.9 percent of those in full-year programs and 6.1 percent in summer programs had abnormal test results.
- Of the children given vision screening tests, 8.4 percent of those in full-year programs and 9.2 percent in summer programs were found to have abnormal vision.

Project Head Start was designed as a comprehensive program for disadvantaged children and their families. An important, basic aim of the program has been to make sure that Head Start children receive the health services they need. The program remains the only nationwide comprehensive health care program for preschool children.