

Astigmatism in Zuni and Navajo Indians*

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ABSTRACT

Data provided by a practicing optometrist in Gallup, New Mexico indicate a greater than expected frequency of astigmatism among first- and second-grade Zuni and Navajo Indian children. Zuni children displayed a great frequency of high astigmatism (3.00 D) than Navajo children. In an effort to understand the etiology of this prevalence of high astigmatism, a study of corneal astigmatism in 22 Zuni families was undertaken. The results suggest both genetic and environmental causes. A very high frequency of albinism was also observed among the Zuni.

The cornea contributes about two-thirds of the total refractive power of the eye. An irregularity in its curvature usually provides the major contribution to the amount of astigmatism. Consequently, factors that might cause corneal astigmatism have practical importance.

The average physiological corneal astigmatism reported by Duke-Elder¹ is about 0.50 to 0.75 D (with greater power in or near the vertical meridian). Duke-Elder¹ and Kapoor² have suggested that any value over 1.00 D should be regarded as aphysiological.

There is still a great deal of controversy about the causes of corneal astigmatism.³ One view associates it with the pressure of the eyelid on the cornea.⁴ Another view associates it with the pattern of growth. This latter hypothesis is based on the observation that corneal astigmatism changes in amount and direction with age.⁵

Very little has been found about the influence of heredity on corneal astigmatism. Recent studies by Lyle⁶ and by Young et al.⁷ have indicated that the influence of heredity on refractive error is insignificant. Wixson,⁸ on the other hand, has revealed a pattern of inheritance of corneal astigmatism in which both parents appear to determine corneal characteristics. Wixson,⁹ Hofstetter and Rife,¹⁰ and Gros-

venor¹¹ have found a high correlation between identical twins' total refractive error but little or no correlation between the corneal curves as measured by keratometry.

These findings, then, leave one to hypothesize that high corneal astigmatism is due to genetic causes, environmental causes, or a combination. Furthermore, one might assume that high astigmatism is a by-product of high refractive error.

In 1968, T. J. Heard (personal communication) brought to our attention the increasing rate of high astigmatism (3.00 D and greater) among young Zuni and Navajo Indians. This observation led us to study some selected Zuni families in 1968 and 1970 to see whether a genetic factor was responsible.

SUBJECTS

The Zuni live in a small area in the southwestern United States. Their custom of first-cousin marriage has produced a high degree of inbreeding. Groups of families live in very small, closely grouped dwellings, equipped with electric lighting but exposed to a great amount of dust from jewelry making. The older members of the community are mostly occupied in jewelry making and fire fighting as their vocations. Younger people in general avoid these vocations.

The Navajo do not practice first-cousin marriage. They live in wide-open areas, in smaller family units than the Zuni. We observed the Zuni to have mongoloid eyes with heavy folds in the upper lids and a high incidence of chronic conjunctivitis. Bettman,^{12, 13} has reported that ocular diseases such as trachoma, retinoblastoma, phacomorphic angle-closure glaucoma, and iridocyclitis associated with pulmonary tuberculosis occur more commonly among the Indians of the Southwest than in the general population and that some diseases have a tribal predilection. He has also reported that active trachoma was seen most commonly among Indians under age 20 and that blinding complications occurred principally in middle-aged and older adults. These findings, coupled with our observation of chronic conjunctivitis, suggest

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that extreme exposure to dust and sunlight may be influencing the shapes of the developing corneas in young Zuni.

PROCEDURE

In 1968, Katherine Arancha, assistant at the Public Health Service field center at the New Mexico Zuni Village, examined medical files at the center and selected 25 families for this study. Each family had at least one child with corneal astigmatism greater than 1.00 D. Examination of the medical files revealed no record of trachoma. However, eye examinations showed many chronic lid infections. At a voluntary screening, age, visual acuity, keratometer readings, and spectacle refraction were ascertained for each family member who attended. Again in 1970, measurements were made on the same families. This time the sample included many members screened in 1968 and some others. Comparison of the 1968 and 1970 data indicated good agreement between the keratometer readings of those members who attended both times. Further, no systematic change in corneal astigmatism was found. This observation is in agreement with the results of Hirsch.¹⁴ In 22 of 25 families, all the siblings were screened at least once. Only the data on these 22 families are considered in further discussions.

RESULTS

Retinoscopic data supplied by T. J. Heard on 382 Zuni and 337 Navajo children in the 1st and 2nd grades were analyzed. Astigmatism was found to be "with-the-rule" in all cases. This with-the-rule astigmatism was divided according to degree into 3 groups: 0 to 1.00 D (low), 1.25 to 2.75 D (medium), and 3.00 D and greater (high). The results are presented in Table 1 and are compared with findings of Woodruff¹⁵ and Lyle et al.¹⁶ Medium and high astigmatism are more common among the Zuni and Navajo children than among Caucasian children. Particularly, high astigmatism is far more common among the Zuni than among the Navajo or Caucasian children. Abraham and Volovick¹⁷

also point out the high frequency of astigmatism among Navajo children.

The sample of 22 Zuni families consisted of 166 persons—67 males and 99 females. Data on both parents could be collected in only 11 of the 22 families. Table 2 lists the distribution of corneal astigmatism by degree in each family. In most of the families, the members cluster around one or two degrees of astigmatism. For example, in family number 4, all 6 members (12 eyes) have high astigmatism; in family number 14, all members have either low or medium astigmatism; in family number 15, most members have either medium or high astigmatism. In other words, the range of corneal astigmatism within each family is smaller than the range in the whole population.

All the siblings in 4 of these families showed high corneal astigmatism. In 2 of those families, the mothers had high corneal astigmatism. (In the other 2 families, data on mothers were not available, and fathers did not have high astigmatism. The result may indicate a genetic component in high astigmatism.) Data on both parents were available in too few families for a meaningful correlation study.

Another observation was made on 14-year-old female identical twins. Both girls had corneal astigmatism of 4.25 D in both eyes. Their mother had corneal astigmatism of 4.75 D in the right eye and 4.25 D in the left eye. Data on the father were not available. Three brothers, 11, 7, and 5 years old, had corneal astigmatism ranging from 3.25 D to 5.00 D. These findings would suggest that if corneal astigmatism was due to environmental factors, these factors must have affected the children at a very early age. On the other hand, it is probable that there was some influence by genetic factors.

Most of our subjects indicated the presence of chronic lid infections, which was confirmed by the public-health physician, who had found such infections very frequently in the Zuni population. The swelling caused by chronic infection of the double-folded Mongoloid lids could, in our opinion, have exerted molding pressure on the corneas of young children.

TABLE 1. Percentage of children's eyes exhibiting low, medium, and high degrees of astigmatism

Degree of astigmatism (D)	Retinoscopy		Keratometry		
	Zuni Indians ^a Grades 1-2 (N = 382)	Navajo Indians ^a Grades 1-2 (N = 337)	Canadian children ¹⁵ 2-6 yrs (N = 270)	Canadian Caucasians ¹⁶ 7-14 yrs. (N = 323)	Canadian Indians ¹⁶ 7-14 yrs (N = 230)
0-1.00	54.7	63.0	94.8	86.4	43.2
1.25-2.75	18.3	24.2	4.1	12.1	49.8
3.00 or more	27.0	12.8	1.1	1.6	7.0

^a Data from T. J. Heard, personal communication.

TABLE 2. Distribution of corneal astigmatism in Zuni families

Family no.	No. of members	No. of eyes in each category		
		Low (0-1.00 D)	Medium (1.25-2.75 D)	High (3.00 D)
1	8	0	16	0
2	6	1	8	3
3	9	2	13	3
4	6	0	0	12
5	5	4	6	0
6	9	6	9	3
7	2	0	0	4
8	9	2	0	6
9	4	5	1	2
10	3	0	6	0
11	8	5	6	5
12	12	5	11	8
13	5	0	4	6
14	12	10	13	0
15	14	3	12	13
16	6	2	1	9
17	10	5	7	8
18	5	0	5	5
19	6	1	7	4
20	11	8	10	4
21	5	1	4	5
22	8	1	14	0

Albinism was observed in 45 Zuni children of ages between birth and the early teens. The total population of the Zuni during this period of study was 5000, indicating the frequency of albinism to be 1%. According to Fonda,¹⁸ the frequency of albinism among the general population in the United States is 1 in 100,000. Therefore, among the Zuni, albinism is 100 times as prevalent as in the general population. Two major factors could contribute to this high prevalence. First, albinism is an inherited defect, and second, there is a large amount of inbreeding among the Zuni.

CONCLUSION

The main purpose of this paper is to point out the problem of an unusually high frequency of high astigmatism among the Zuni. Because of this problem, it is important that good eye care be provided to these people as early in life as possible to prevent development of problems like refractive amblyopia and strabismus as well as failure to develop behavior and skills that depend on good vision.

From this study it has not been possible to determine to what extent, if any, astigmatism is genetic. There is some indication that genetic influence is present, particularly in high astig-

matism. A more detailed study of larger samples of Zuni and Navajo people may yield more answers to the question of genetic influence.

A more detailed study of the problem of albinism among the Zuni should be undertaken. If the results establish inheritance as a factor in the increase in astigmatism, a program of genetic counseling should be offered to the Zuni so as to minimize the occurrence of high astigmatism. The high rate of albinism observed indicates a study of familial relationships. Hence, the possibility of instituting genetic counseling should be considered with some immediacy.

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Haffner Elected Board Chairman Manhattan Health Plan

Dr. Alden N. Haffner has been elected Chairman of the Board of Directors of a newly developing health maintenance organization (HMO).

This federally funded project is known as Manhattan Health Plan, Inc. It has been given a grant of \$996,000 to initiate a comprehensive health care program which will include optometric care and services. Manhattan Health Plan, Inc. is an Article 28 corporation of the State of New York.

Plans for the initiation of the health program are scheduled for the summer of 1977. Henry Berman, M.D., has been designated as the plan's medical director. Others on the Board of Directors are Mrs. Edith Fisher and Mr. Robert Adams. Dr. Haffner is president of the State College of Optometry, State University of New York.