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EAR DISEASE AND HEARING LOSS AMONG NAVAJO CHILDREN — A MASS SURVEY.*†§‡

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ABSTRACT.

A team of trained technicians in a specially equipped mobile van conducted a mass screening effort on the Navajo Reservation from 1978 to 1980 to detect and refer individuals with ear disease and hearing loss; 15,890 school children were examined. The prevalence data and correlations of hearing level with ear disease are presented: 4.0% of the children had TM perforations, 2.3% middle ear effusions, 1.9% TM atelectasis, and 0.4% had sensorineural hearing loss. Microtia was found in 1:935, with a cluster on the Western one-fourth of the reservation. Cholesteatoma was rare. The patterns of ear disease are contrasted with other groups.

It has been recognized for many years that among North American Indians the occurrence of certain ear disease, notably chronic otitis media with perforation, is significantly more common than among the general American population. The hearing losses associated with this and related conditions create an educational handicap for a large number of Indian children.[1] Concern over this endemic health problem of Indians in the late 1960's led to a proposal by the Indian Health Service in 1969 for special emphasis on the treatment of ear disease. Congress agreed to fund Otitis Media Project contracts, under which efforts were made to identify and treat Indians with ear disease. Within the Navajo Reservation, this resulted in the training and equipping of a team of technicians who screened school children for audiometric, tympanometric, and otoscopic abnormalities. The present study is an analysis of their findings from the 1978-80 examinations of the Indian students in the Headstart programs and the Bureau of Indian Affairs (BIA) schools on the reservation. In all, 15,890 students were examined, making this one of the largest surveys of its kind. The results have been analyzed to yield epidemiologic data and correlations of hearing loss with disease. Implications for the design of hearing screening programs in high-risk populations will be discussed in a future report.

METHODS AND MATERIALS.

The screening was carried out in a specially equipped mobile trailer equipped with a double-walled Tracoustics RE 142B sound booth, a Grason-Stadler 1701 audiometer, and an American Electromedics 83 tympanometer. Audiometer calibration was checked after every change in location of the trailer. The trailer was also equipped with a Zeiss operating microscope, a suction unit, and all appropriate instruments for wax removal and pneumatic ear examination. Three Native American technicians performed the audiometric examinations. They were trained for this purpose at the Otolaryngology Departments of the University of Colorado and the Gallup, New Mexico Indian Medical Center. Initially the team was supervised by an otolaryngologist and audiologist. The technicians received continuing education in audiometry and otology several times annually. By the time of this survey the team had over 6 years of experience and functioned either autonomously or with an audiologist. The opinion of the PHS otolaryngologists receiving referrals from this team was that their work was reliable, the otoscopics being comparable to that of a resident in otolaryngology.

Otoscopic examination was performed first, using the Zeiss microscope in all cases. Cerumen was removed if possible, and any discharge was suctioned and noted. Otoscopic abnormalities included deformed auricles, otitis externa, drainage, tympanic membrane (TM) perforations, abnormal TM mobility, TM retraction, cholesteatoma, and acute otitis media.

Tympanometry was performed next. Flat tracings and negative pressure peaks of minus 150 mm H_2O or more were classed as failures, as were ears with drainage and children who could not cooperate. An audiologic screen was performed by presentation of pure tones at 20 dB HTL at 500, 1000, and 2000 Hz, and at 30 dB at 4000 Hz. Non-responders to any one frequency failed the screen. Children who failed any section of this triad received a determination of their actual hearing thresholds for speech and for pure tones by air conduction. Bone conduction thresholds were usually obtained if there was hearing loss, and masking was used where appropriate. Children were triaged into diagnostic categories as much as possible, and these lists were forwarded to the school nurse and the relevant Indian Health Service facility.

The team attempted to examine all the students within these surveyed schools. During the 1978-80 survey, it was possible to screen 87% of the BIA schools and 56% of the Headstart programs on the Navajo Reservation. A check of enrollment figures from one-fifth of the schools revealed that 97.5% of the enrolled students were screened. Public schools were not surveyed.

RESULTS.

In all, 15,890 children were surveyed. BIA high school programs are generally located outside Indian Reservations, so the bulk of surveyed children are aged 4 through 14 years. Because the screening effort was not conceived of as an epidemiologic study at that time, detailed data were kept only on the 1609 abnormals identified. An age breakdown of the 1609 is presented in Figure 1; 855 (53.1%) were male and 754 (46.9%) were female. The failure rates per screened modality are given in Table I, and a more detailed breakdown of pass-fail combinations

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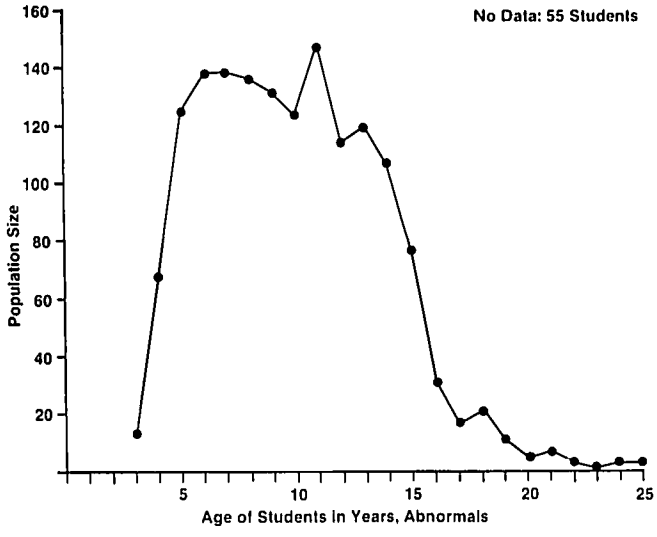

Fig. 1.

is shown in Table II. More abnormals were found by otoscopy than by any other single method utilized. The majority of those identified failed all three modalities.

The screening technicians exercised their judgment in pursuing evidence of hearing loss, and some of the children screened were preschool age, so not every child had pure tone thresholds at every frequency from 250 Hz to 8000 Hz. For the purpose of presenting data on hearing loss in various ear diseases, the speech reception threshold (SRT) has been chosen as the most meaningful and most frequently available measure of hearing. Where this is unavailable, the average of the two best pure tone thresholds in the 500-2000 range is presented (pure tone average, PTA). Where both SRT and PTA are available, an analysis shows that they agree within 10 dB 94% of the time.

Results of the microscopic ear examinations have been analyzed and presented in Table III. There were no significant differences between right and left ears for any abnormality based on a two-tailed chi-square test. Tympanic membrane perforations are the most common finding, with a 4.0% prevalence rate; 19% of these were bilateral and 17% were draining at the time of examination. Selected audiometric diagnoses are also presented in Table III. Significant hearing loss in the speech range as defined by SRT or PTA greater than 20 dB has been found in 3.8% of the study population, with bilateral loss in 0.7%.

Diagnoses have been correlated with hearing threshold in the speech range for TM perforations, middle ear effusions, TM atelectasis, otorrhea from all causes, cholesteatomas, wax impactions, cases of microtia, and losses which are partly or entirely sensorineural in the speech range. These results are presented in Figures 2-10.

TABLE I.
Failure Rate by Modality.

Modality Failed	Number Failing	Failure Rate
Audiometry	1168	7.4%
Tympanometry	1255	7.9%
Otoscopy	1450	9.1%
One or more modalities	1609	10.1%
Two or more modalities	1382	8.7%
All three modalities	882	5.6%

DISCUSSION.

The most important finding of this mass survey is the high prevalence of chronic otitis media with perforation among Navajo children (4.0%). We also found moderate amounts of TM atelectasis (1.9%) and serous otitis (2.3%) and rather low, by comparison, incidence of cholesteatoma. The 61 children (0.38% of the total) with sensorineural losses comprised the bulk of the larger hearing losses.

Several observers have found the prevalence of eardrum perforations in Indian groups to be higher than in Caucasians or Blacks. In 1969 Jaffe[2] examined 2000 Navajo children from reservation boarding schools and found that 4.2% had at least one TM perforation; 17% of these were bilateral and 29% of these were actively draining. Johnson (1967)[3] looked at a similar group and found 6.4% with chronic otitis media and 1.2% who had had successful tympanoplasties. Zonis[4] found that 8.3% and 10.7%, respectively, of the residents of two Apache communities had TM perforations. On the Mt. Currie Reservation in British Columbia, 13.7% had TM perforation, otorrhea, or cholesteatoma.[5] Surveys of various Eskimo communities have yielded estimates of 4.4%,[6] 18.3%,[6] 30.8%,[7] 30.4%,[8] 26.8%,[1] and 5.3%[9] for the prevalence of chronic otitis media. Some Indian tribes appear to be more affected than others. The authors concur with the impression of Wiet that Navajos and Apaches are more commonly affected than other southwestern Indian tribes,[10] and to this we would add the Hopis.

In contrast, the occurrence of chronic TM perforation is much less common in other American and European populations. A study of Pittsburgh school children yielded a TM perforation prevalence of 0.5% per ear,[11] and a screening of Swedish school

TABLE II.
Pass-Fail Combinations.

Audiometry	Tympanometry	Otoscopy	Number	Percent
Pass	Pass	Pass	14,281	89.9
Pass	Pass	Fail	104	0.7
Pass	Fail	Pass	19	0.1
Pass	Fail	Fail	318	2.0
Fail	Pass	Pass	104	0.7
Fail	Pass	Fail	146	0.9
Fail	Fail	Pass	36	0.2
Fail	Fail	Fail	882	5.6
All	All	All	15,890	100.0

TABLE III.
Prevalence of Selected Conditions.

Condition	Number of Students	Prevalence
TM perforations	643	4.0%
Bilateral	125	0.79%
Draining	124	0.78%
Marginal	27	0.17%
Pinpoint	73	0.46%
Middle ear effusions	370	2.3%
Bilateral	164	1.0%
TM atelactasis	306	1.9%
Bilateral	137	0.86%
Microtia	17	0.11%
Bilateral	2	0.01%
Otitis externa	107	0.67%
Bilateral	6	0.04%
Cholesteatoma suspected	11	0.07%
Bilateral	0	0
Otorrhea	203	1.3%
Bilateral	22	0.14%
Wax impactions after reasonable attempts at removal	60	0.38%
Bilateral	29	0.18%
Acute otitis media	7	0.04%
Bilateral	0	0
Speech frequency loss 20 dB in either ear	607	3.8%
Bilateral speech frequency loss 20 dB	108	0.70%
Pure or mixed sensorineural loss in speech range	61	0.38%
Bilateral	13	0.08%

children yielded the same figure.[12] Australian aborigines, a Third World people of Melanesian stock, have been found to have TM perforations in 11.7% of ears examined.[13]

There is a divergence of opinion on the relative frequency of serous otitis in Indians. Johnson and Cambon[3,5] reported essentially no serous otitis, Zonis[4] quoted a 1% figure for Apaches, and Gregg[14] quoted the same figures for Sioux. However, Cambon and Zonis did not routinely use pneumatic otoscopy. On the other hand, a significant portion of the otitis encounters for Goodwin (14.3%)[15] and for Wiet (20%)[10] were for serous otitis media. Jaffe[2] grouped serous otitis media and TM atelectasis together and found it in 4.8% of his Navajo children. If we combine the same diagnoses in our group, we derive the similar figure of 4.2%. Serous otitis was our second most frequent diagnosis, found in 370 children, 2.3% of the total. Thus we have found a moderate amount of serous otitis. This is notably less than the 5.7% prevalence found in mostly white school-age groups in Denmark,[16] but the same as the 2.3% figure in a mixed American population in Pittsburgh.[11] It is the clinical impression of the authors that serous otitis is frequent in Indians, but that its pattern is different from that in whites, who tend to develop non-inflamed "glue ears" in the school years, often for long periods of time. Navajos tend to have middle ear effusions along with a mild chronic inflammation of the drum, and this "subacute otitis media" seldom lingers more than 1-2 months. This pattern is usually found in preschool children. Weider observed higher rates of serous otitis and lower rates of TM perforation in locations where Alaskan Eskimos had easy access to medical care. He hypothesized that early treatment of acute otitis media may favor this pattern.[10]

In contrast to the generally high rate of chronic otitis media among Indians, most observers have

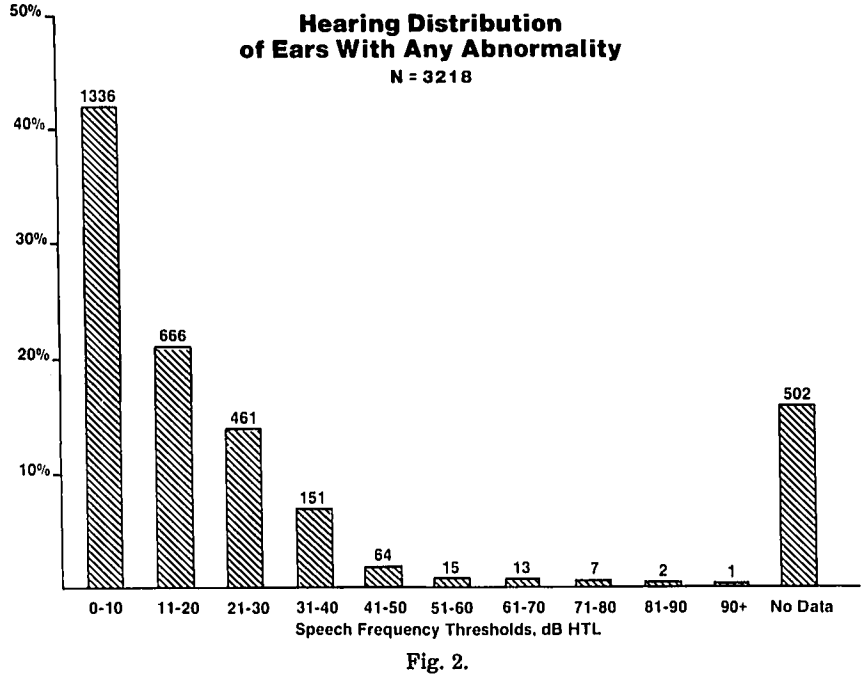

Fig. 2.

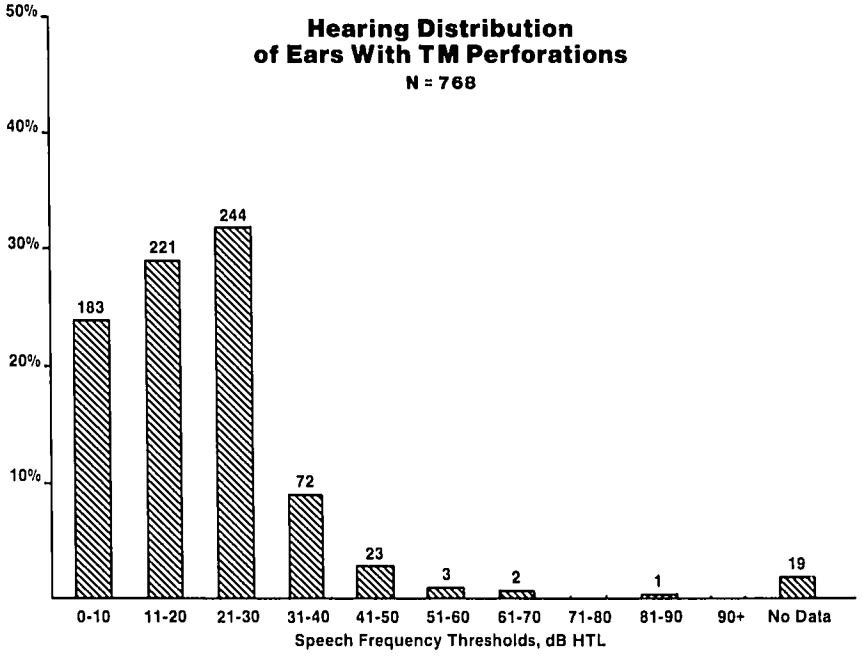

Fig. 3.

not found correspondingly high rates of cholesteatoma. Zonis[4] and Jaffe[2] found no cases in their study populations, and Johnson[3] reported only rare cases. Ratnesar[17] compared the ear disease patterns between Eskimos, Indians, and Caucasians along the Labrador Coast. He found that for a given number of surgical procedures for chronic otitis, Caucasians were 6 times more likely to have a cholesteatoma than Eskimos and Indians. In contrast, Cambon[5] reported a 0.2% definite and 0.8% probable incidence of cholesteatoma on the Mt. Currie Reservation; these are rather high figures. Among Australian aborigines, McCafferty[13] found a high rate of TM perforation (11.7% of ears) and a very low rate of cholesteatoma (0.05% of ears). Our survey found very few cases. The authors' experience is that flagrant cholesteatomas are rare, but not unheard of. Much more commonly seen are deep posterior-superior quadrant retraction pockets only beginning to collect debris. Most are limited in their growth by extremely sparse mastoid pneumatization and do not behave aggressively.

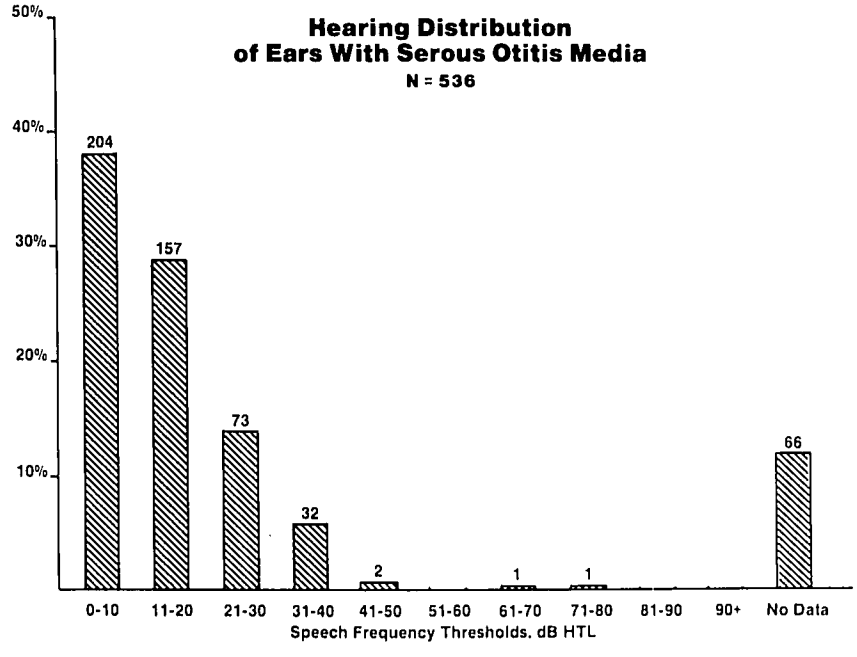

Fig. 4.

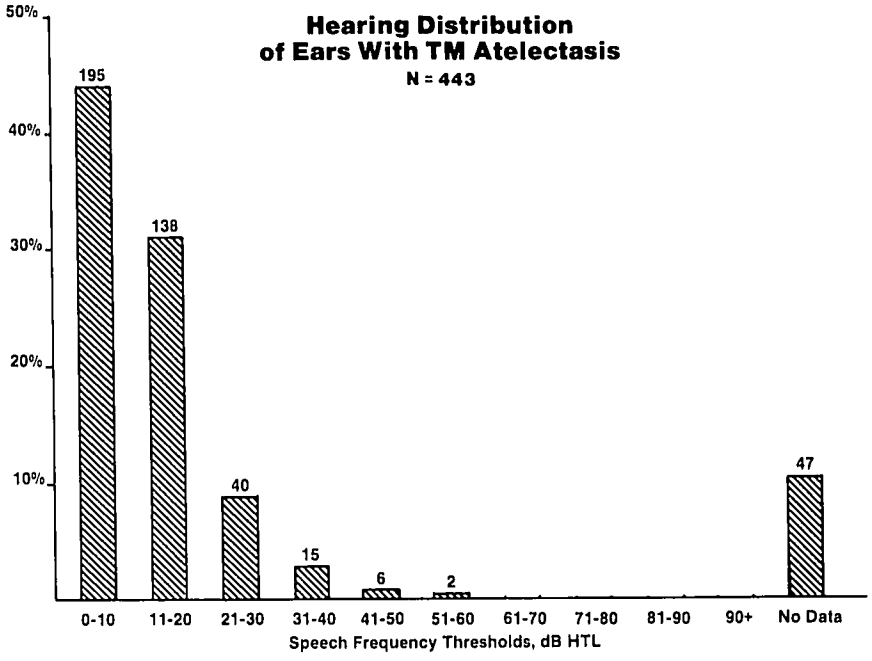

Fig. 5.

Otitis externa was not particularly frequent, with a prevalence rate of 0.67%. When present, it was usually due to previous otitis media. The dry, comparatively cool climate of the Colorado plateau does not favor this disease.

Microtia was seen in 17 patients, 2 bilaterally, for a prevalence rate of 1:935. Using a different method than ours, Jaffe[2] estimated that the newborn incidence on the Navajo Reservation for 1948-68 was 1:1200 live births. Nine of our cases were found on the western one-fourth of the reservation, a fact which is just short of statistical significance.

Sensorineural losses in the speech range occurred frequently enough that in most of the larger schools a few cases were found. These children are among the more seriously hearing-impaired, as seen in Figure 10. The present study did not cover high-frequency losses, which will be the subject of a follow-up analysis. Children with bilateral moderate to severe losses are for the most part in special pro-

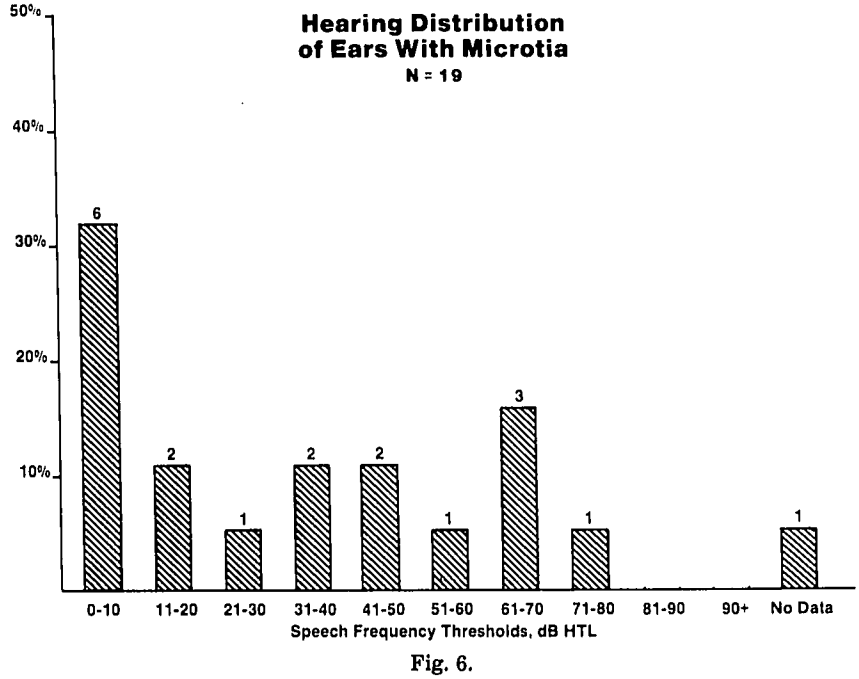

Fig. 6.

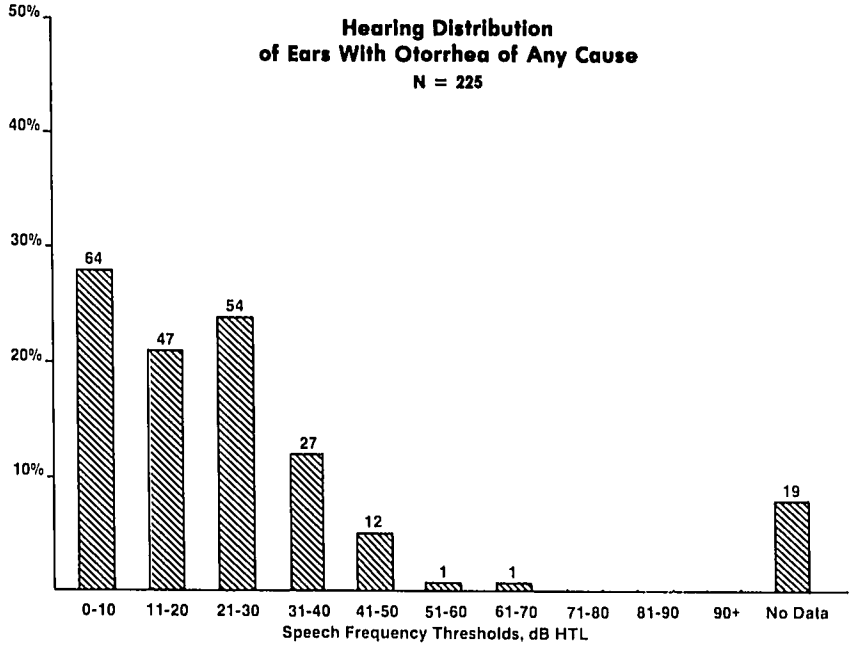

Fig. 7.

grams off the reservation, so that the prevalence of sensorineural loss quoted here is artificially low.

Residuals of old ear disease, such as tympanosclerotic plaques and thin monomeric areas on the TM, were not specifically noted by the screening team. We estimate that these are present in over one-third of the Navajo population; these do not in themselves cause a hearing loss. The common occurrence of tympanosclerosis has been noted by several observers,[2,10,17,18] and may hold a key to the predisposition of Native Americans to TM perforation.

The retrospective nature of this analysis does not allow many conclusions to be drawn about the causes of ear disease and its particular pattern among Navajos. In regard to the frequently heard suggestion that low socioeconomic status may correlate with ear disease, it has been our strong clinical impression that the Indian children of the comparatively affluent hospital employees are as likely to appear in clinic with TM perforations or recurring acute otitis media as children from remote areas without electricity and plumbing. There is probably more refractory otorrhea in poorer pa-

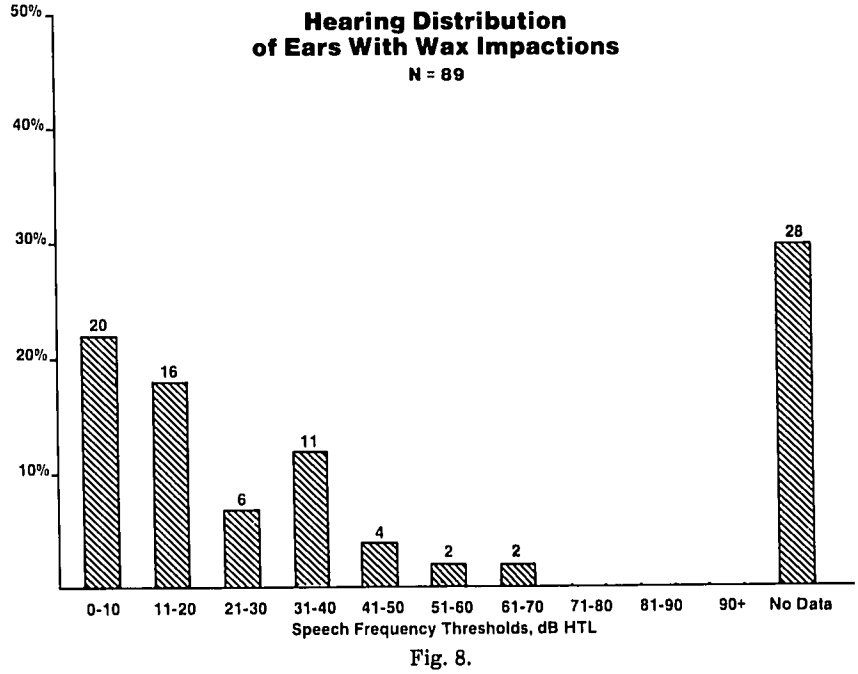

Fig. 8.

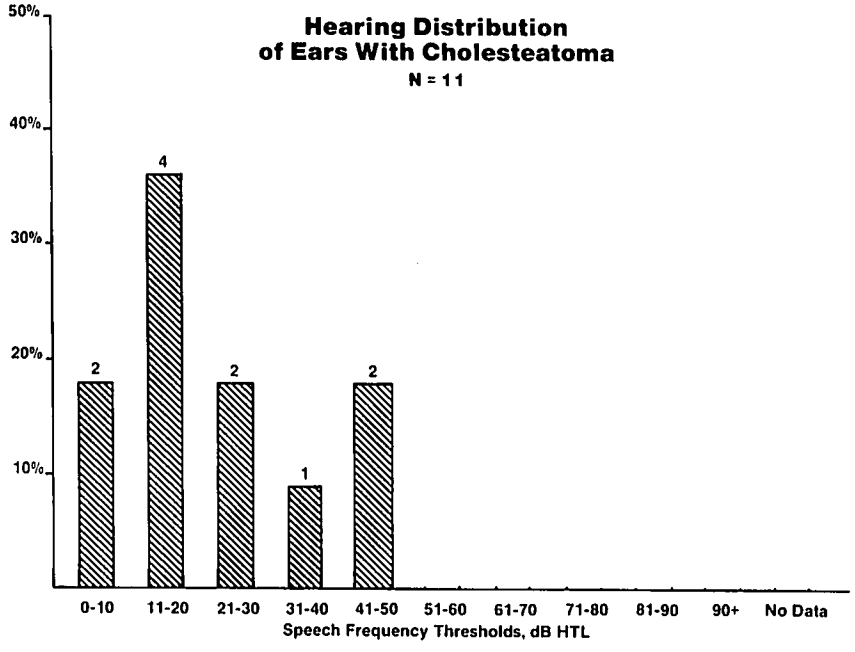

Fig. 9.

tients. Aside from this, there has been no clinically obvious connection between economic well-being and disease pattern. Numerous examples of otitis-prone families have been seen. Spivey's comparisons of disease rates for Apache children adopted into non-Indian homes with their non-Indian siblings and with reservation Apaches are interesting. The adopted Apache children had significantly lower rates of pneumonia and diarrheal illness than their Reservation counterparts, but the otitis media rates were not significantly lower.[19] Shaw, *et al.*, followed every child born for 5 years on 4 of the smaller Arizona Indian reservations prospectively for the first year of life. They were unable to show a significant correlation between the otitis media attack rate and any environmental variable studied except for proximity to a health facility, which correlated positively.[20]

Given the demonstration of high levels of chronic otitis media among Indians and the slow rate of improvement in this, it is unfortunate that we are in an

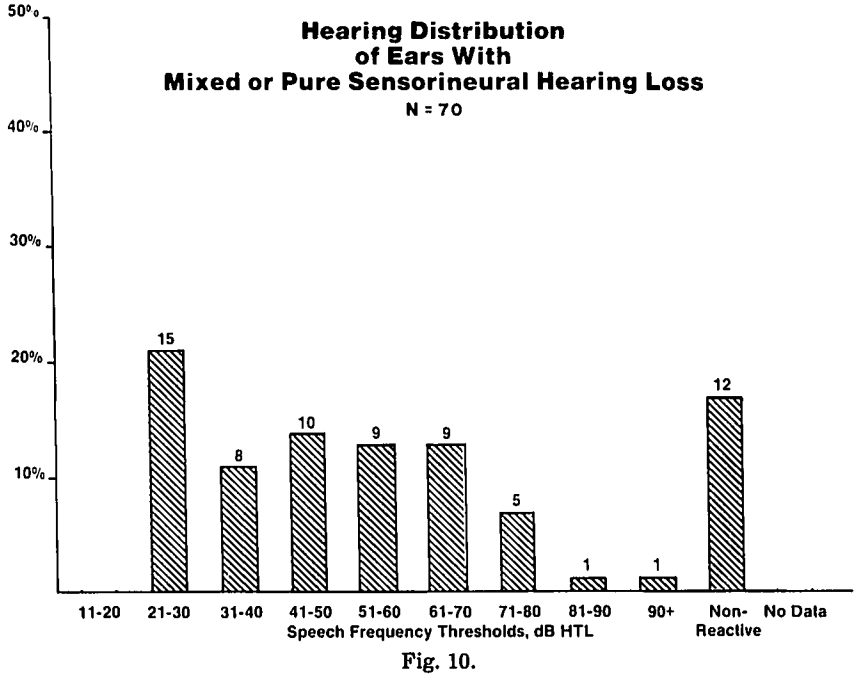

Fig. 10.

era of cutbacks in health care for native Americans. Availability of medical services nearer the home areas of more patients is a key to improving patient attitudes toward seeking this care. Another practice which has shown its value is the employment of medically trained laymen who speak the various Indian languages. Examples are found in PHS Field Health Nursing programs, tribal Community Health Representative programs, and in specialized areas such as Otitis Media Project technicians. The changes in community health attitudes that are central to a successful attack on health problems are in great part due to their efforts. All three of the programs mentioned are at present undergoing a series of cutbacks for budgetary reasons, and the Otitis Media Project screening team has been dismantled, with its members being assigned other duties.

Given the high rates of chronic otitis media with TM perforation among Native Americans, there is a clear need for prospective studies to determine the causes of this problem. Research into the pathogenesis of tympanosclerosis may yield practical clinical information, particularly for the high-risk population of this study. On the Navajo Reservation, it would be desirable to maintain a surveillance program in the schools for detection of ear disease. It appears that new cases of chronic otitis media are being generated almost as frequently as 15 years ago, and we should not consider this problem solved.

The use of trained otoscopic technicians has been shown to aid in identifying cases needing medical treatment, and is encouraged for similar high-risk groups. Technicians chosen from the native population can be trained to recognize ear disease, and are available in educating their own people about the nature of ear disease and its modern treatment.

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DISCUSSION.

Voice from the Floor: Do you think it could be serous otitis because these patients are progressing to chronic otitis with perforation? Do you think that's why your incidence was so low?

SCOTT M. NELSON, M.D. (Portland, ME): That's a good theory, a good hypothesis, and may also have something to do with the low incidence of cholesteatoma, which I feel is a complication of ear drum retraction.

RICHARD L. RUGGLES, M.D. (Cleveland, OH): I've been told that the Indians are troubled by dry ear canals. I wonder if you then had that experience, or lack of apocrine glands including those in the externa?

DR. NELSON: The nature of the cerumen is different from that in Caucasians by and large. Most Indians have dry wax. Not particularly abnormally dry, but I think it's a pattern that is similar to that in Oriental people.

Voice: What about otosclerosis?

DR. NELSON: This is quite rare in the American Indian. We do see some cases of conductive hearing loss. We see more of congenital stapes fixation than we do of otosclerotic disease.