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A study of the visual status of Washington Indians

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Abstract

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by

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A C K N O W L E D G M E N T S

We would like to extend our appreciation to everyone who helped us complete this paper, All of the fourth year interns who had to fill out all of the forms, Dr. Fred VanNus who made sure all the interns filled out all the forms, Michelle Cheslock for putting in overtime hours typing, Linda Coppedge for smiling every time we sat in the "waiting room" and of course many thanks to Dr. Larry Clausen without whose help we would still be trying to decide what to put on the recording forms.

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BACKGROUND

Optometric examinations were performed at the Quinault, Colville and Chehalis Indian reservations, all of which are located in the state of Washington. Although not all of the many reservations in the state are included in this study, there is a good cross-sectional population. The Quinault reservation is located on the coast of Washington and is mainly dependent upon its lumber and fishing industries. The Chehalis reservation, while also in western Washington, is a smaller, inland reservation relying more on outside employment. The largest reservation of the three in terms of area, Colville is also the most cosmopolitan.

The examinations included refraction, analytical findings, biomicroscopy and, for individuals forty and over, tonometry. These examinations were performed, under faculty supervision, by fourth-year interns participating in Pacific University's Indian Health Service externship program. The equipment consisted of: a keratometer, projector with accessory slides, phoropter, standardized near point cards, retinoscope, ophthalmoscope, stereoscope and a biomicroscope.

A total of 345 patients were examined between June 1979 and mid-October 1979. The ancestry of all the patients was such that they were eligible for care through the Indian Health Service. All patients were required to sign a release form (Appendix A-1). After completion of the individual examination and case analysis, data for this study was recorded on a standardized form (Appendix A-2). The raw data obtained from the record form was transfered onto computer opti-scan sheets (Appendix A-3) for eventual computer data processing.

FINDINGS

After the raw data was tabulated, the findings were reduced using only right eye data where applicable. Data was further reduced into ten categories selected by the authors. Unless specified, a total of 345 patients were involved in the various categories of this study. Data comparisons were done by sex and age.

Refractive Error. The mean spherical correction for the Washington Indian population was -0.41 diopters. There is essentially no difference between the mean spherical refractions of the male and female populations ($\bar{x}$ males -0.40 diopters, $\bar{x}$ females -0.41 diopters). The mean spherical correction varied with age, starting at a hyperopic mean which goes into myopia and later goes back into hyperopia. (Figure 1)

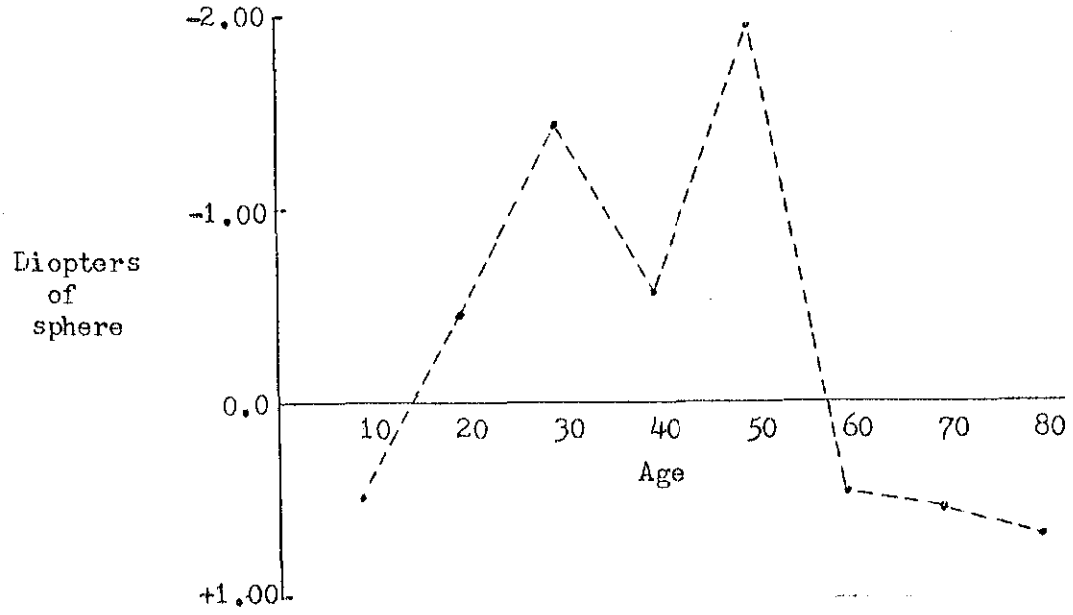

FIGURE 1 Mean Spherical Refraction by age

The mean corneal astigmatism for the Washington Indian population was 0.99 diopters. The mean refractive astigmatism

for the Indian population was 0.71 diopters. The mean corneal and refractive astigmatism does not appear to vary by age or sex. The only age group which varied considerably from the population mean was the 30-39 age group. This was due to five individuals with greater than 3.00 diopters of astigmatism. (Table 1)

	Total	Males	Females	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70 & up
Mean corneal cylinder (diopters)	0.99	1.06	0.95	1.00	0.87	1.08	1.51	0.88	0.79	0.81	0.77
Mean refractive cylinder (diopters)	0.71	0.77	0.67	0.71	0.52	0.62	1.19	0.68	0.56	0.79	0.93

Table 1 Mean Corneal & Refractive Astigmatism in diopters by age

Myopia. Myopia represented the largest percentage of spherical refractive error. (Figure 2) Within the population there is no apparent difference due to sex. Myopic males comprise 40.3% of the male population and myopic females comprises 39.9% of the female population.

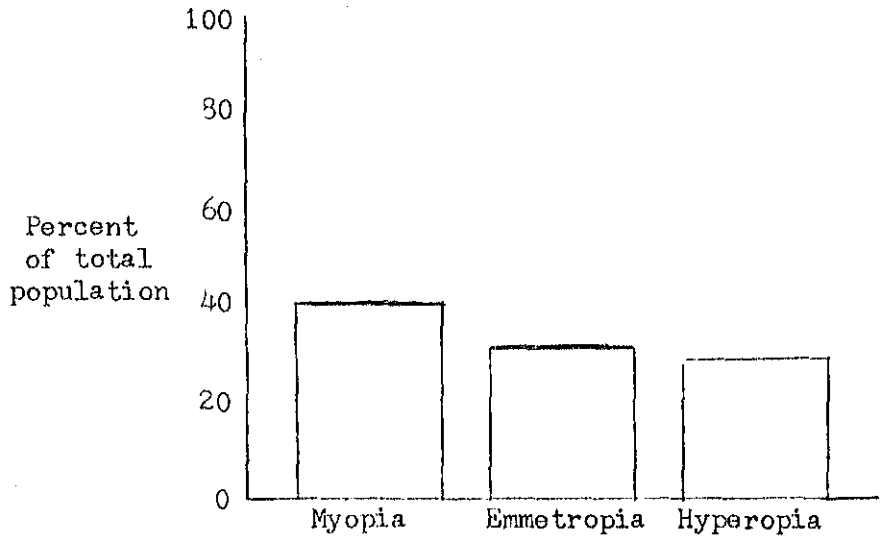

FIGURE 2 Prevalence of Spherical Refractive Error

With respect to age, the percentage of myopic patients increased up to age 30, dropped slightly to age 50, and then

declined significantly. (Figure 3) The sharpest increase in the prevalence of myopia was between the 0-9 and 10-19 age groups. however, the 20-29 age group had the highest percentage of myopes, 60.0%.

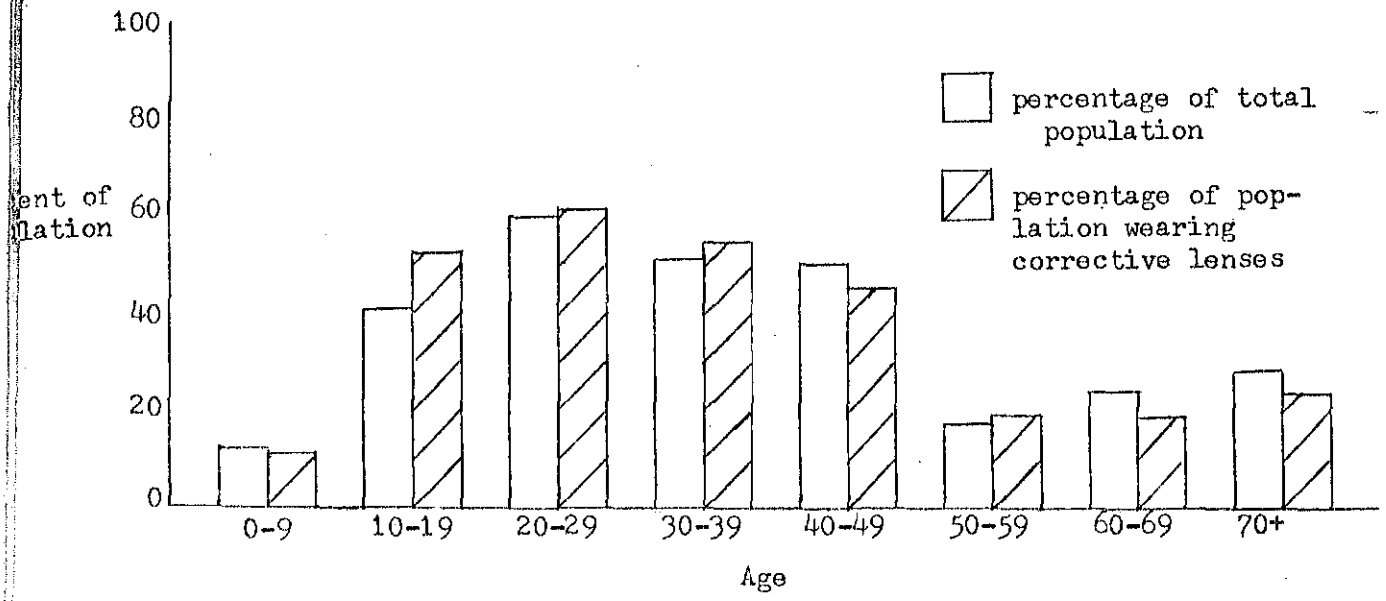

FIGURE 3 Prevalence of Myopia with age

Approximately 42% of the Washington Indian population wearing corrective lenses were myopic. The prevalence of myopia by age follows a pattern similar to that of the total Washington Indian population. (Figure 3)

Hyperopia. Hyperopia had the lowest prevalence of refractive error, comprising 28.9% of the 332 patient population. The male population had a lower percentage of hyperopic patients (23.4%) than emmetropic patients (36.3%). On the other hand, the female population exhibited a reverse relationship, having 32.2% hyperopes and 27.9% emmetropes. The prevalence of hyperopia by age groups showed and inverse relationship with the prevalence of myopia in the same age groups. The percentage of hyperopes decreased with age until age 30 and increased gradually until age 50. The pervalence of hyperopia increased dramatically after 50 years. (Figure 4)

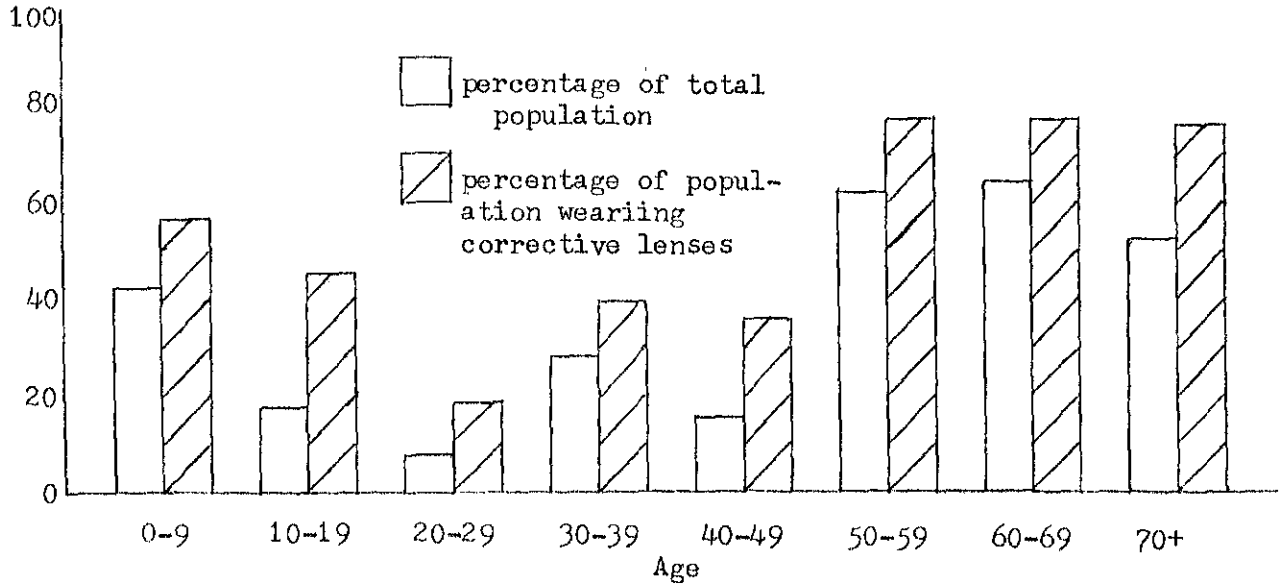

FIGURE 4 Prevalence of Hyperopia with age

With respect to age, the prevalence of hyperopia in the Washington Indian population wearing corrective lenses follows the same pattern as the total Indian population. (Figure 4)

Astigmatism. The majority of the population showed low amounts of corneal and refractive astigmatism. Corneal measurements of 0.99 diopters of cylinder or less were found in 50.3% of the 302 patients measured and refractive measurements of astigmatism of 0.99 diopters or less were found in 70.5% of the 332 patients refracted. The prevalence or amount of corneal or refractive cylinder does not appear to vary by age or sex. (Table 2)

Diopters of Astigmatism	Total	Males	Females	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70 & up
Corneal											
0-0.9	50.3%	47.8%	51.9%	58.3%	55.6%	40.4%	27.9%	58.3%	55.3%	71.4%	61.5%
1.0-1.9	36.1%	38.1%	34.9%	33.3%	32.1%	48.1%	46.5%	27.8%	37.9%	19.0%	38.5%
2.0-3.0	8.3%	8.0%	8.5%	14.8%	8.6%	7.7%	11.7%	8.3%	3.4%	4.8%	0.0%
3.1 & up	5.3%	6.1%	4.7%	3.6%	3.7%	3.8%	13.9%	5.6%	3.4%	4.8%	0.0%
	100%										
Refractive											
0-0.9	70.5%	71.0%	70.2%	75.0%	82.8%	69.1%	56.8%	80.5%	70.6%	57.8%	42.4%
1.0-1.9	19.9%	16.1%	22.1%	12.5%	10.4%	25.5%	22.7%	12.2%	23.5%	34.6%	38.1%
2.0-3.0	5.7%	9.7%	3.4%	8.3%	3.4%	3.6%	9.1%	2.4%	5.9%	3.8%	19.0%
3.1 & up	3.9%	3.2%	4.3%	4.2%	3.4%	1.8%	11.4%	4.9%	0.0%	3.8%	0.0%
	100%										

As expected, the majority of the Washington Indian population with astigmatism were with-the-rule (cylinder axis 0^0 to 30^0 or 150^0 to 180^0). Although no observations of differences due to sex were made, age appeared to be a factor in axis orientation. Past age 40, the percentage of subjects with against-the-rule astigmatism increased and the percentage of with-the-rule astigmats decreased. (Table 3)

				Age							
Cylinder axis	Total	Males	Females	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70 & up
0^0-30^0, 150^0-180^0(WTR)	52.5%	62.2%	46.2%	72.7%	55.2%	63.6%	70.5%	46.3%	35.3%	23.1%	19.0%
60^0-120^0 (ATR)	20.0%	18.1%	21.1%	6.1%	11.5%	12.7%	9.1%	17.1%	20.6%	61.5%	71.4%
30^0-60^0, 120^0-150^0(oblique)	3.7%	3.9%	3.7%	0.0%	1.1%	0.0%	4.5%	12.2%	8.8%	3.8%	4.8%
Spherical	23.8%	15.8%	28.5%	21.2%	32.2%	23.7%	15.9%	24.4%	35.3%	11.6%	4.8%
	100%										

WTR=with-the-rule astigmatism ATR=against-the-rule astigmatism

TABLE 3 Cylinder axis

Visual Acuity. The habitual acuities at far equalled or surpassed the 20/30 level for 81.7% of the population, and, at near (40 cm), 83.2% of the population. At both distances the percentage of females with 20/30 acuity or better was slightly lower than for males. As expected, acuity did vary by age. Habitual distant acuity of 20/30 or better dropped steadily after age 60, and acuity at near dropped steadily after age 40. (Table 4)

				Age							
Acuity level	Total	Males	Females	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70 & up
Far											
20/30 and above	81.7%	86.2%	79.1%	93.9%	81.4%	81.8%	84.8%	90.6%	91.2%	73.0%	39.1%
20/40 to 20/60	10.1%	6.9%	12.1%	6.1%	8.1%	5.5%	6.5%	4.7%	5.9%	19.2%	47.8%
20/70 or below	8.2%	6.9%	8.8%	0.0%	10.5%	12.7%	8.7%	4.7%	2.9%	7.8%	13.1%
Near											
20/30 and above	83.2%	86.9%	80.9%	93.9%	97.7%	94.6%	91.3%	73.8%	64.7%	69.2%	30.4%
20/40 to 20/60	12.1%	10.8%	14.4%	6.1%	2.3%	5.4%	6.5%	19.0%	29.4%	15.4%	56.5%
20/70 or below	3.7%	2.3%	4.7%	0.0%	0.0%	0.0%	2.2%	7.2%	5.9%	15.4%	13.1%

TABLE 4 Habitual Visual Acuities
-prevalence of acuity levels

As expected, corrective lenses increased the acuity levels for all ages. All age groups, with the exception of the 70 years and above group, had at least 95% with corrected acuity of 20/30 or better at both far and near. (Table 5)

				Age							
Acuity level	Total	Males	Females	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70 & up
Far											
20/30 and above	95.0%	96.9%	94.0%	97.0%	100%	100%	100%	95.2%	100%	96.2%	43.5%
20/40 to 20/60	4.1%	2.3%	5.1%	3.0%	0.0%	0.0%	0.0%	2.4%	0.0%	3.8%	47.8%
20/70 or below	0.9%	0.8%	0.9%	0.0%	0.0%	0.0%	0.0%	2.4%	0.0%	0.0%	8.7%
Near											
20/30 and above	95.4%	96.9%	94.4%	97.0%	100%	100%	97.8%	97.6%	100%	96.2%	47.8%
20/40 to 20/60	3.8%	3.1%	4.2%	3.0%	0.0%	0.0%	0.0%	2.4%	0.0%	3.8%	43.5%
20/70 or below	0.8%	0.0%	1.4%	0.0%	0.0%	0.0%	2.2%	0.0%	0.0%	0.0%	8.7%

TABLE 5 Maximum Visual Acuity (prevalence)

Pathology. Ocular pathology was observed in 31.6% of the Washington Indian population. Cataracts were the most common type of pathology, accounting for 26.6% of all pathologies observed. Conjunctivitis, corneal opacities and/or scarring, pingueculae and pterygiae accounted for 32.1% of the observable pathology. Pathology was more frequently detected on the two inland reservations than on the Quinault Reservation. However, the percentage of patients with observable pathologies that required referral was higher for the Quinault Reservation. (Table 6)

	Quinault	Colville	Chehalis	Total
onjunctivitis	11	1	1	13
lepharitis	2	2	0	4
ataracts	14	10	5	29
enile Macular Degeneration	1	5	1	7
orneal Scarring/Opacities	6	3	2	11
rusen	4	1	3	8
ypertensive Retinopathy	2	5	3	10
iabetic Retinopathy	2	0	1	3
itreous Floaters	2	5	2	9
stroid Hyalosis	3	0	0	3
inqueculae/Pterygium	4	7	0	11
ry Eye Syndrome	4	3	1	8
ests Disease	3	0	0	3
etached Retina	1	0	0	1
etinitis Pigmentosa	1	0	0	1
oxoplasmosis/Histoplasmosis	1	0	0	1
rachoma	0	1	0	1
ther	13	7	5	25
ubjects with Pathology (% in parenthesis)	54(23.8%)	38(47.5%)	17(44.7%)	109(31.6%)

TABLE 6 Observable Pathologies of the Washington Indian population

Out of the total population 10.7% were referred due to observable pathology. This group represented 33.9% of the patients with observable pathology. Referrals to private ophthalmologists were the most numerous, accounting for 43.3% of all referrals. (Table 7)

thology Referrals	Quinault	Colville	Chehalis	Total
ivate Ophthalmologist	8 (33.3%)	6 (75%)	2 (40%)	16 (43.2%)
blic Health Service Hosp.	8 (33.3%)	0 (0%)	3 (60%)	11 (29.7%)
servation Clinic	8 (33.3%)	2 (25%)	0 (0%)	10 (27.1%)
Referred for Pathology (% of subjects with Path of some kind)	44.4%	21.1%	29.4%	33.9%
Referred for Pathology (% of subjects referred from total pop.)	10.6%	10.0%	13.2%	10.7%

TABLE 7 Pathology Referrals

Strabismus. A total of four patients (1.2) were found to be strabismic. One individual was exotropic and three were esotropic. With respect to the three esotropes, one was an intermittant alternating esotrope, one was an accomodative esotrope and the other was unspecified.

Presbyopia. Some degree of presbyopia was found in 33.6% of the population examined. First noted in the 30-39 age group, all patients were presbyopic by age 60. (Figure 5).

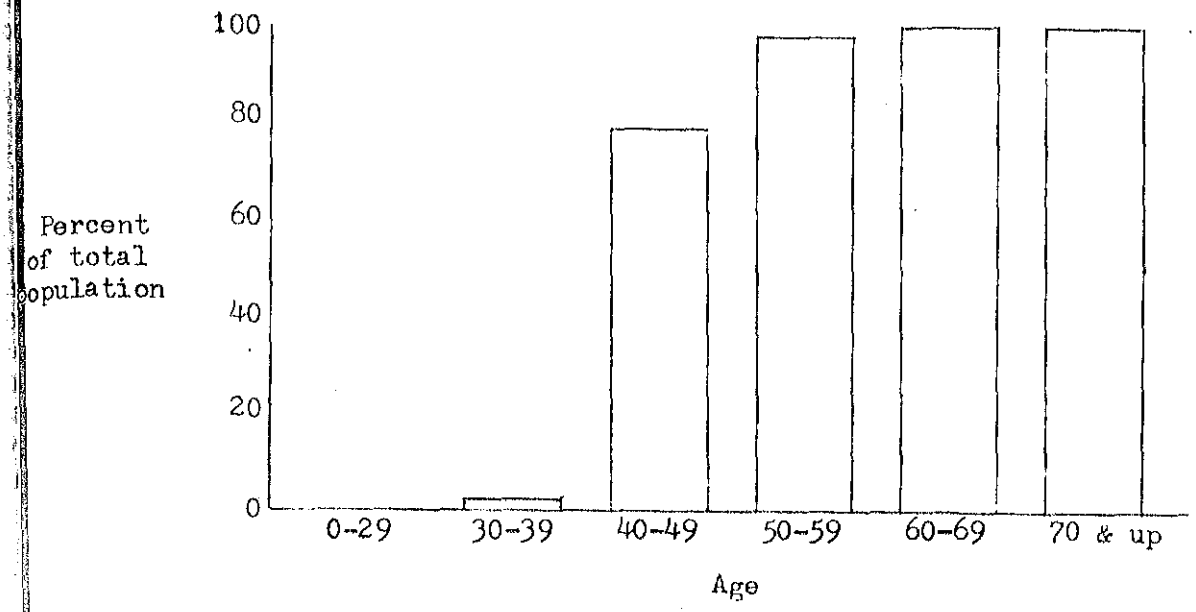

FIGURE 5 Prevalence of Presbyopia with age

Amblyopia. Only two cases of amblyopia were found in the total population examined (0.6%).

Phorias. Nearly 70% of the 292 Washington Indian patients examined were orthophoric at distance. The mean phorias of the different age groups ranged from 0.39 prism diopters of exophoria to 0.36 prism diopters of esophoria.

At forty centimeters, the majority of the 293 patients exhibited 2-6 prism diopters of exophoria with a mean of 5.21 prism diopters. An increase in exophoria at near with age was found, increasing from a mean phoria of 2.35 prism diopters of exophoria in the 0-9 age group to 7.14 prism diopters of exophoria in the 60-69 age group. (Figure 6)

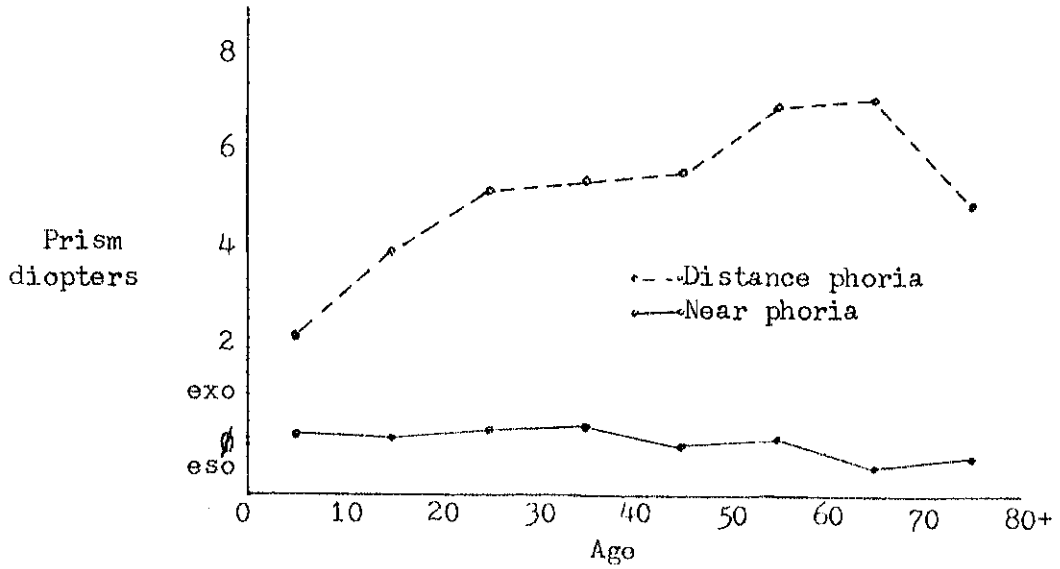

FIGURE 6 Far and Near Phorias with age

Therapy. A previous prescription was worn or new corrective lenses were prescribed for 76.5% of the 345 patients examined. Corrective lenses were ordered for 60.3% of the total population. This includes first prescriptions, a change in prescriptions or replacement of damaged or lost prescriptions. No change in prescription was prescribed for 16.2% of the total population.

There was a substantial increase in patients who needed a correction in the 10-19 age group, frequently for correction of myopia. The percentage of corrections needed gradually increased after age 19, leveling off at age 40 with approximately 90% of the older age group populations needing correction. (Table 8)

				Age							
precription	Total	Males	Females	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70 & up
First	25.8%	32.8%	21.9%	24.2%	37.2%	25.5%	21.7%	33.3%	26.5%	0.0%	8.7%
Change of	22.3%	20.8%	23.3%	3.0%	4.7%	20.0%	10.9%	38.1%	44.1%	65.4%	34.8%
Replace	12.2%	10.8%	13.0%	0.0%	10.5%	23.6%	21.7%	11.9%	2.9%	7.7%	8.7%
No Change	16.2%	10.8%	19.5%	0.0%	8.1%	16.4%	28.3%	9.5%	20.6%	26.9%	39.1%
No prescription needed	23.5%	25.3%	22.3%	72.8%	39.5%	14.5%	17.4%	7.1%	5.9%	0.0%	8.7%

TABLE 8 Therapy

DISCUSSION

The discussion contains two comparisons; the first is a comparison between the Washington Indian population studied and the general U.S. population; the second is a comparison between previous Indian population findings and the findings for the Indian population of this study.

When comparing results between the National Center for Health Statistics for the U.S. population and the Washington reservation population, differences were noted in the prevalence of refractive cylinder and myopia. The Indian population had a smaller prevalence of myopia and a greater prevalence of refractive cylinder. Simularities exist for hyperopia prevalence and visual acuity levels. Hyperopic prescriptions accounted for a slightly greater portion of the Indians than for the U.S. population. The percentage of Indian individuals at specified acuity levels closely parallels that of the U.S. citizens. No conclusion can be made with respect to therapy since the data collection procedures of the National Center of Health Statistics differed with our procedures.

Comparison of the Washington Indian population with the general U.S. population

Myopia. A considerable difference is noted in the prevalence of myopia corrections by age group with the U.S. population having the greater prevalence.

According to the National Center for Health Statistics, 47.6% of the total U.S. population wearing corrective lenses were myopic. The percentage of individuals corrected for myopia increased from 38.4% in the 4-5 age group to 87.1% in the 12-17 age group. After this age, the percentage of myopic corrections

decreased steadily, with only 14.9% of the 65-74 age group wearing such corrections.[1] (Figure 7)

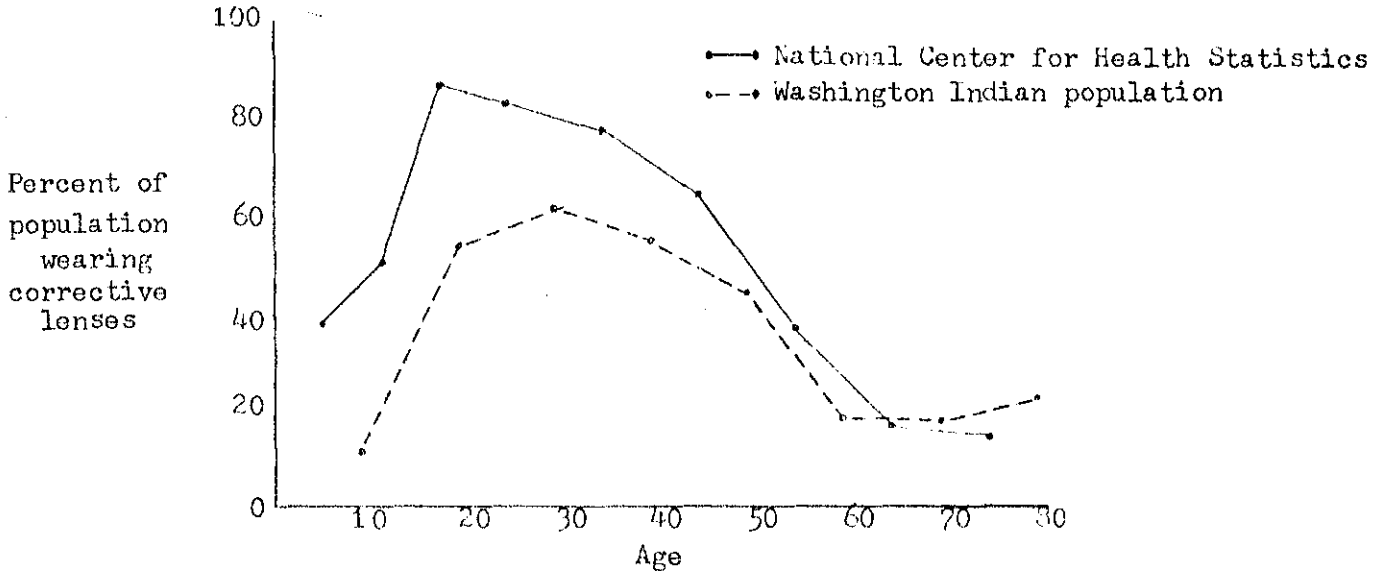

FIGURE 7 Myopia by age

A lower percentage of Indians in our study wear myopic corrections (42.4%), but the prevalence of myopia follows a similar pattern to the U.S. population. (Figure 7) Only 11.0% of the 0-9 age group wore myopic prescriptions. The percentage increases, reaching a maximum of 61.7% prevalence in the 20-29 age group. After this age, a decrease is observed until age 50.

Hyperopia. No relative difference is noted in the prevelance of hyperopic corrections by age.

Corrective lenses for hyperopia are worn by 46.6% of the U.S. population who wear corrective lenses.[2] Hyperopia decreased with age, dropping from 58.8% prevalence in the 4-5 age group to 10.2% in the 12-17 age group. After this age, a gradual increase in hyperopic corrections is observed until reaching a maximum of 79.9% prevalence in the 65-74 age group.[2] (Figure 8)

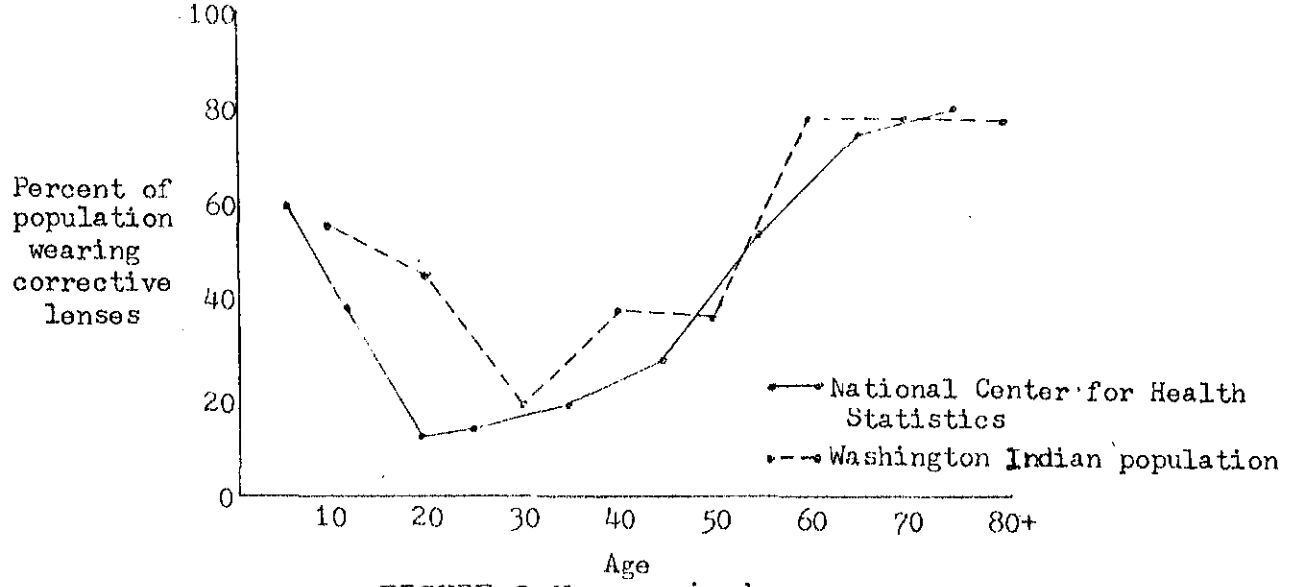

FIGURE 8 Hyperopia by age

A smiliar percentage of the Indian population wear corrective lenses for hyperopia (48.5%) and exhibits a similar pattern of variance exists by age group. (Figure 8) Hyperopia decreased from 56% for the 0-9 age group to 19% for the 20-29 age group and then increases to approximately 77% for the age group 50 years and older.

Refractive Cylinder. The prevalence of refractive cylinder is higher at all age groups for the Indian population.

Approximately 63% of the U.S. population studied, those wearing corrective lenses, had some amount of cylinder in the correction. There was little variation in cylinder with age, ranging from 54.3% in the 6-11 age group to 70.2% in the 4-5 age group.[3] (Figure 9)

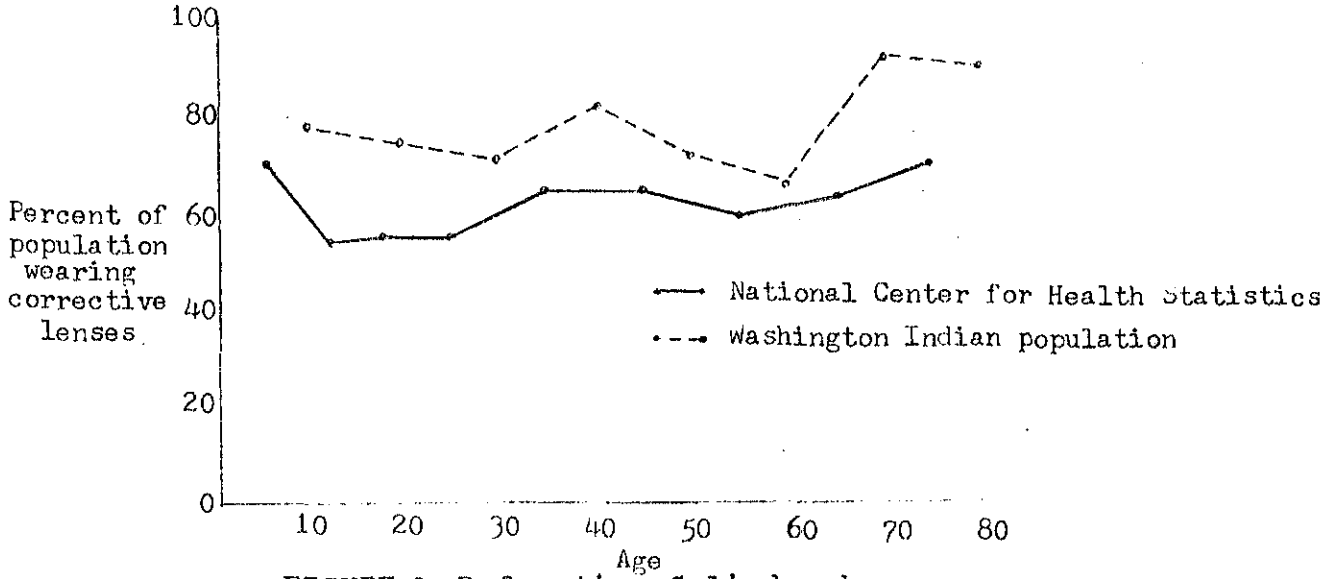

FIGURE 9 Refractive Cylinder by age

For the Indian population wearing corrective lenses, 76.5% had some form of cylindrical correction. The prevalence, as in the U.S. population, varies only moderately with age, ranging from 66% in the 50-59 age group to 92% in the 60-69 age group. (Figure 9)

Visual Acuity. A close parallel exists between the Washington Indian population and the general U.S. population for visual acuity.

Until age 65 a visual acuity level of 20/30 or better could be achieved by over 90% of the U.S. population. After age 65 the percentage of individuals able to reach this level decreases to 78.4%. Even with this decrease, 95.4% of the total U.S. population can obtain or surpass the 20/30 acuity level.[4] (Figure 10)

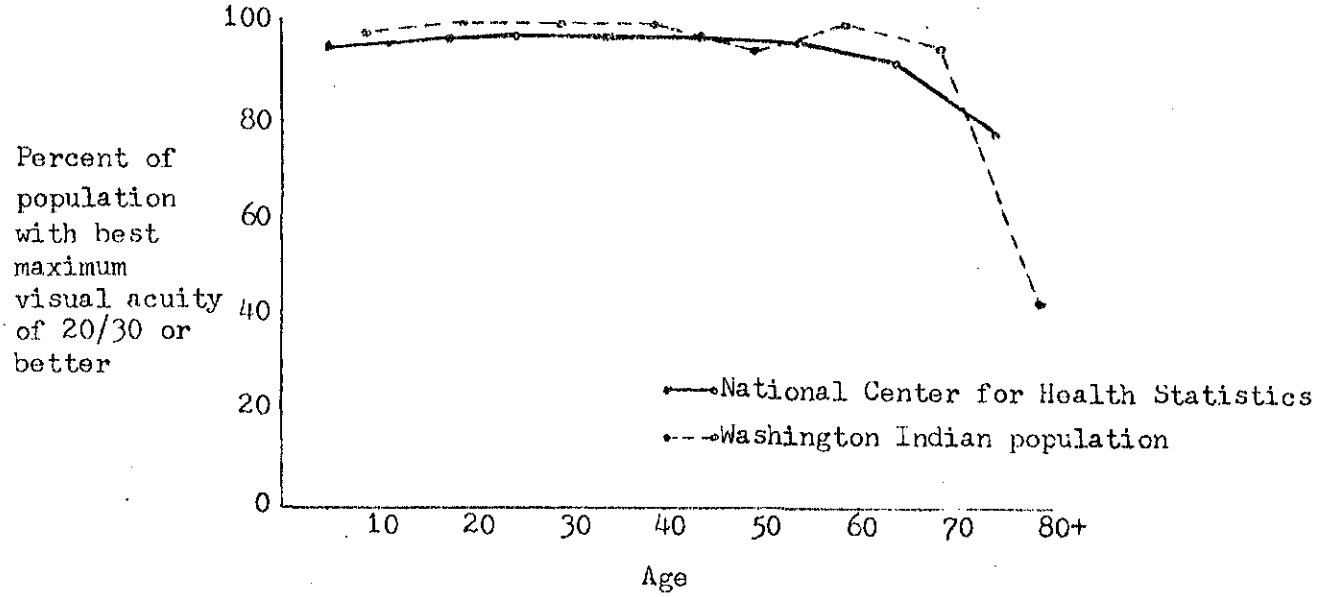

FIGURE 10 Visual Acuity 20/30 or better by age

As expected, in the latter years when fewer patients can attain the 20/30 acuity level the percentage of individuals at lower acuity levels increases. The percentage of the U.S. population attaining 20/40 to 20/60 vision increases from age 55, where 7.5% are at this level, to the 65-74 age group, where 19% are at the 20/40 to 20/60 level. (Figure 11) Virtually no individuals were unable to attain 20/60 acuity or better until age 65. After this age the percentage of individuals with 20/70 acuity or less

increases to 2.6%.[5] (Figure 12)

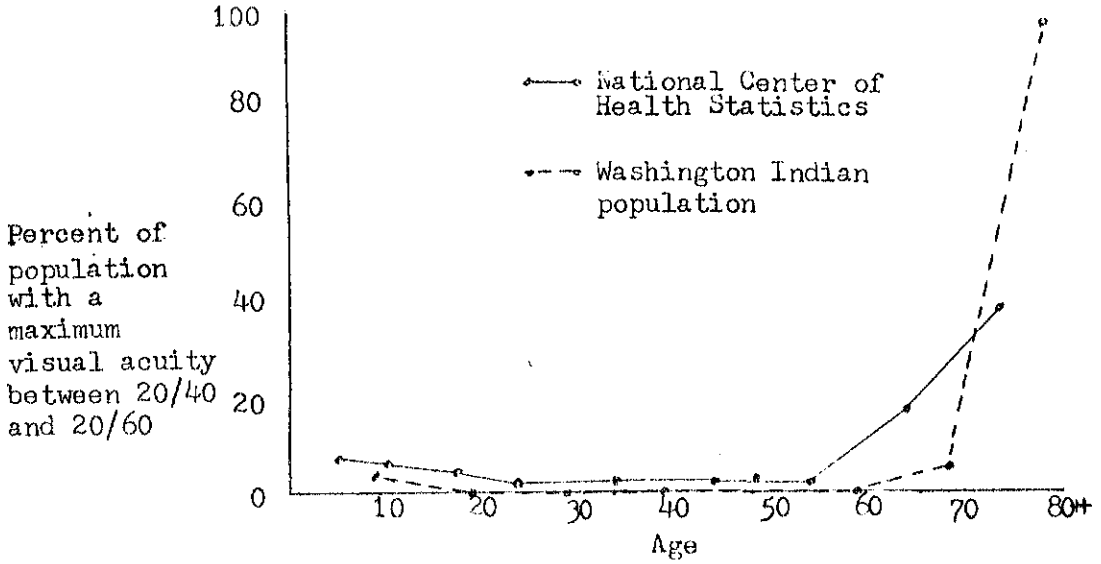

FIGURE 11 Visual Acuity 20/40 to 20/60 by age

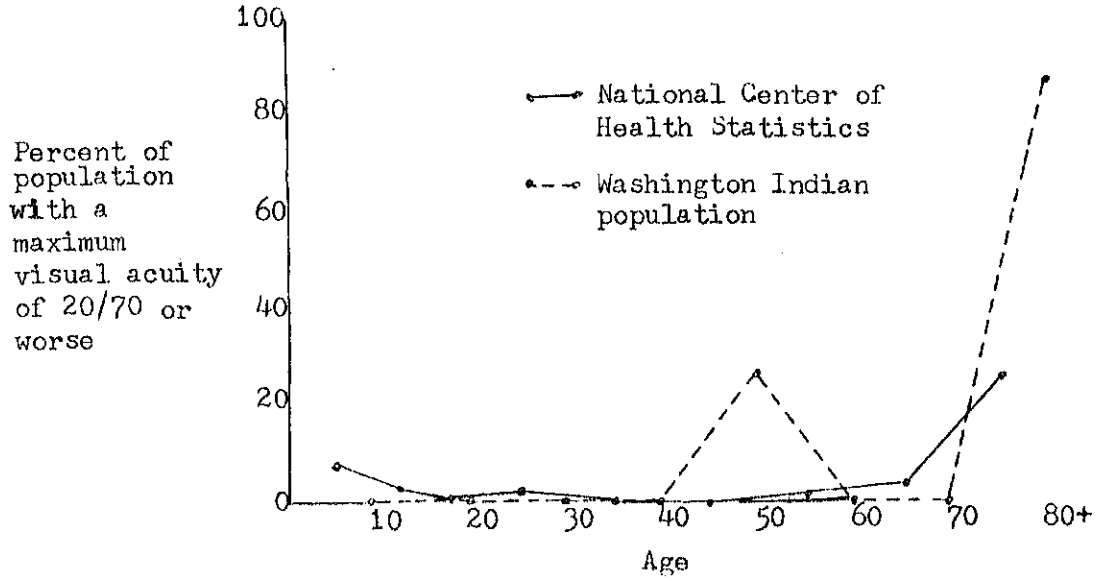

FIGURE 12 Visual Acuity 20/70 or worse by age

The Washington Indian population follows the same pattern as the U.S. population. The 20/30 acuity level was reached or surpassed in 95% of the total Indian population. All age groups had at least 95% of their population with 20/30 acuity or better until age 70 and older. A dramatic decrease in acuity in the 70 and older group brought the percentage of patients with 20/30 acuity down to 43.5% of the group. (Figure 10)

The percentage of individuals with 20/40 to 20/60 acuity increased slightly in the 60-69 age group. At ages 70 and over the prevalence rose sharply from 3.8% to 47.8%, a 44% increase. (Figure 11) The percentage of individuals with poor acuity (20/70 or less) remained at or near zero until after age 69, where 8.7% of the 70 year and over group could achieve no better than 20/70 acuity. (Figure 12)

Therapy. No firm conclusions can be drawn about therapy due to differences between this study and the National Center for Health Statistics study.

A simularity exists between the Indian population wearing corrective lenses prior to examination and the U.S. population reported by the National Center for Health Statistics. The percentage of the Indian population wearing corrective lenses after examination is much higher than the U.S. population wearing corrective lenses. However, one cannot conclude if this difference is significant because the National Center for Health Statistics data does not take into account the population that need corrective lenses but are not currently wearing lenses.

Statistics on the U.S. population show a gradual, steady increase by age in the percentage of individuals wearing corrective lenses. (Figure 13) At ages 6-11, 11.8% wore corrective lenses. The maximum percentage of individuals wearing corrective lenses, 94.1% was found in the 65-74 age group.[6]

The percentage of Indians wearing corrective lenses increased gradually as well. Between the ages 0-9 to ages 20-29 the prevalence increased from 3% to 60%. There was little deviance from the 60% prevalence level until age 50, when the percentage of patients wearing corrective lenses began to increase. The increase reached a maximum of 100% in the 60-69 age group, with a drop to

82.6% in the 70 and over group. (Figure 13)

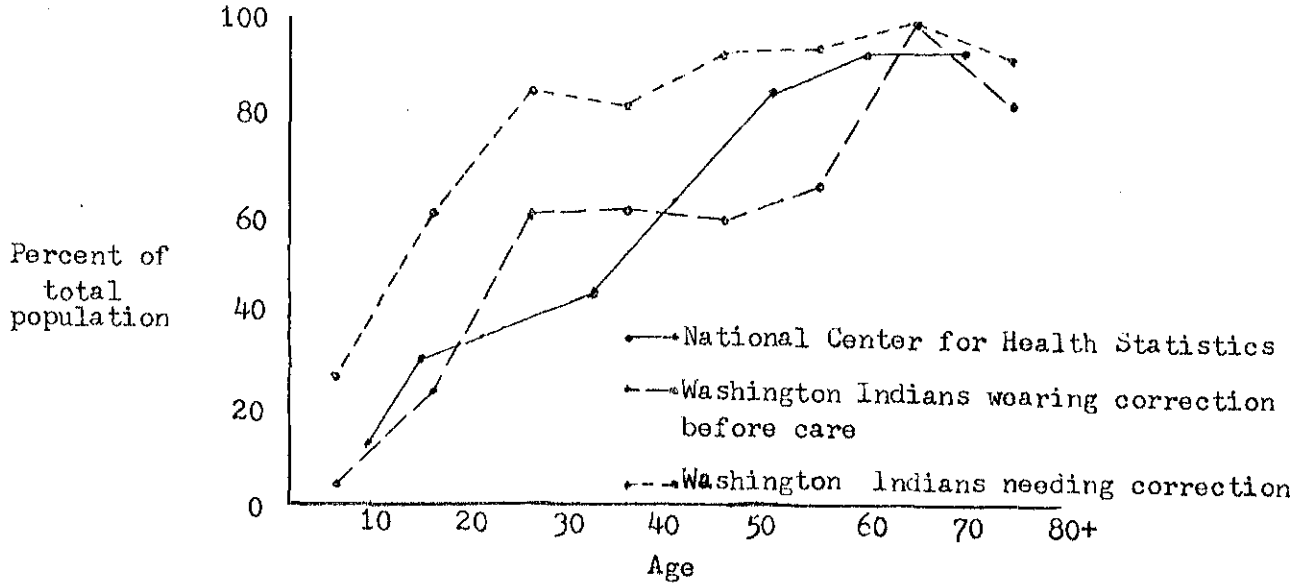

FIGURE 13 Therapy by age

Simularities between the Washington Indians examined and Indian populations previously studied exists in prevalence and degree of myopia and hyperopia, and in the prevalence of corneal astigmatism, refractive astigmatism, pathology and presbyopia. A noticeable difference from previous studies was found for the mean corneal astigmatism, the mean refractive astigmatism and the means of the far and near phorias. The prevalence of stabismus and amblyopia was noticeably lower among the Washington Indian population.

Comparison of the Washington Indian population with previously studied Indian populations

The populations of previous studies include both clinical and screening populations which ranged in number from 138 to 2833. The majority of the studies had school age populations. (Table 9)

Tribe (study)	Population
Sioux (Wick & Crane)	Screenings; Grades 1-5: 178 males & 198 females
Eastern Pueblo (Levy & Wall)	Clinical; Ages 6 to greater than 20; 130 males, 180 females
Zuni (Heard et al)	Screening; Kindergarden through 12th grade; 420 subjects
Northern Indians (Morgan & Munro)	Screening; 631 in astigmatism study; 844 in myopia study
Northern Eskimos (Morgan & Munro)	Screening; 2042 in Astigmatism study; 2833 in myopia study
Saskatchewan (Lyle et al)	Screening; 7 to 14; Not urbanized 230 subjects
Brantford (Lyle et al)	Screening; ages 11 to 15; Urbanized. 191 subjects
Sioux (Boniuk)	Clinical; 951 subjects records used; 502 ages 4 to 19; 536 females
Belcher Island Eskimos (Woodruff/Samek)	Clinical; 138 out of population of 180
Lame Deer (Hamilton)	Screening; 499 subjects; pre-school through 12th grade
Navajo (Abraham & Volovick)	Clinical; pre-school through 12th grade; 462 in sphere study; 520 in astigmatic study
Washington Indians (Larson & Cheslock)	Clinical; 130 males and 215 females

TABLE 9 Comparisons of studies on refractive statis' of different populations

Spherical Refractive Error. The mean spherical refractive error for most of the previous studies show hyperopic means. This is because the populations are mainly school age children. They do, however, show a shift towards myopia with age.

Heard et al found a mean of +0.87 diopters for their kindergarten to sixth grade group and a mean of -0.62 diopters for the seventh to twelfth grade group. Even with this 1.50 diopter

shift towards myopia, the mean of the total school age population examined was between plano and +0.62 diopters.[7] The mean retinoscopic spherical error for the Sioux Indian children screened by Wick and Crane was +0.72 diopters.[8]

Through all age groups Levy and Wall found that the average base spherical correction of the American Pueblo Indians varied from plano to -1.00 diopters.[9] An exception to most other studies, which shows a strong tendency towards myopia, is the Belcher Island Eskimo population. A mean of +0.53 diopters sphere and a standard deviation of ±0.84 diopters was derived by Woodruff and Samek for the Eskimo population.[10]

The Washington Indian population has a more myopic average spherical error than the previous studies. The mean spherical refraction was -0.41 diopters, with age group means ranging from +0.70 diopters to -1.92 diopters.

The shift towards myopia in school age children is exhibited in the Washington Indian population as well. The 0-9 age group has a mean spherical refractive error of +0.52 diopters and the 10-19 age group has a mean spherical refractive error of -0.47 diopters, reflective of the myopic shift.

Myopia. Similar trends exist for myopia but at lower prevalence and amount than previous studies.

A total of 23.7% of the Belcher Island Eskimos examined by Woodruff and Samek had myopic refractive error. In addition, 16.8% of the population were 1.00 diopters or less myopic.[11] In their study of Northern Canadian Indians and Eskimos, Morgan and Munro determined a simularity of moderate myopia (plano to -5.00 diopters).[12] According to Boniuk the most prevalent refractive error in the Sioux Indian population of Northwestern

Ontario was myopia in the range of -1.00 diopters to -5.00 diopters. Severe myopia was not a major factor in any of the previous studies.[13]

In Hamilton's Lame Deer study, 27.9% of the children were myopia referrals. An increase in myopia from 0% in the first grade to 61.5% was noted for the Indian population.[14] Abraham and Volovick projected that close to 50% of all Navajo children between the ages of five and twelve are myopic.[15]

A total of 40.1% of the Washington Indian population was found to be myopic. Myopes of low correction (less than 1.00 diopters) constituted 11.1% of the total population. Severe myopia, over 5.00 diopters, was infrequent accounting for only 2.4% of the entire population.

This study indicates 24.3% of the children have myopia in amounts that would warrant referral in a screening situation. The increase in myopia from grade school age children to older school age children was from 12.5% in the younger group to 40.2% in the older group.

Hyperopia. As with previous studies, a lower percentage of hyperopes than myopes are found in the Washington Indian population.

An exception to the overall populations which show a strong tendency towards myopia, is the Belcher Island Eskimo population. in this group of northern natives, 32.7% were hyperopic and only 23.7% were myopic.[16]

As in the majority of studies, the percentage of hyperopes in the Washington Indian population was lower than the percentage of myopes with hyperopes composing 28.9% of the overall population.

Corneal and Refractive Astigmatism. The Washington Indian population exhibits a higher prevalence but in lower amounts of astigmatism.

Prevalence:

The only information available about the prevalence of corneal astigmatism comes from the Belcher Island Eskimo study. Just 16.8% of the Eskimo population had corneal astigmatism greater than 0.50 diopters. In addition, only 1.4% of the Eskimo population had corneal astigmatism greater than 2.00 diopters.[17] One must note, however, that in most other aspects of visual status the Belcher Island Eskimos have been the exception rather than the rule.

Morgan and Munro found a marked difference in the prevalence of refractive astigmatism between Northern Indians and Eskimos of all ages. In the Eskimo population 61.6% had no astigmatism while 25.5% of the Indian population had no astigmatism. The difference between the stigmatic groups was mainly due to the differences between the mild/moderate groups. In this category the Eskimos exhibited a 35.2% prevalence and the Indians 70.7%.[18] In her study of Sioux Indian children Boniuk discovered the percentage of astigmatic refractive errors to be high. The percentages of astigmatism 1.00 diopters or greater was 33.2%, which compares closely to the 32.9% found in Hamilton's study.[19,20]

The prevalence of corneal astigmatism in the Washington Indians (81.5%) is quite different from that of the Belcher Island Eskimos. This is expected considering the differences exhibited in other comparisons between Indians and Eskimos.

The prevalence of refractive astigmatism in this study (64.8%), correlates closely with other Indian populations. This differs from the prevalence of refractive astigmatism in the Northern Eskimos. A lower percentage of Washington Indian children (19.0%), had 1.0 diopter or greater refractive astigmatism.

Amount:

All previous studies which dealth with mean corneal

astigmatism and refractive astigmatism values involved school age Indian children. Lyle Grosvenor and Dean found a mean corneal astigmatism of 1.39 diopters for the Northern Saskatchewan and Brantford Indian children combined.[21] Sioux Indian children had an average corneal astigmatism of 1.51 diopters.[22] Mean corneal astigmatism values of greater than 2.00 diopters were found by Heard et al ($\bar{x}$ = 2.21) and Mohindra ($\bar{x}$ = 2.43) for Zuni Indian children.[23,24]

The mean retinoscopic astigmatism for the Sioux Indian children of Wick and Crane's work was 1.07 diopters.[25] Heard et al found a median refractive astigmatism of approximately 1.0 diopters for the Zuni Indian children.[26]

Lower amounts of both corneal and refractive astigmatism were found for the school age Washington Indians. The average corneal cylinder of these children (.90 diopters) was noticeably different from previous studies and the average refractive astigmatism of .56 diopters was almost half the amount of previous studies.

Age:

Earlier works show about 0.25 diopters to 0.50 diopters of corneal cylinder change with aging. The prevalence of astigmatism among Navajo children studied by Abraham and Volovick is about normal for the average population but seems to be present in higher degrees in younger children. The Navajo's of high school age showed a higher percentage of incidence but of lower average corneal astigmatism.[27] This is substantiated by Heard et al's observations of the trends of astigmatism amounts with age. They noted a moderate increase in corneal astigmatism between grades 4-6 and kindergarten to 3 (k-3 = 2.35 diopters, 4-6 = 2.4 diopters).

Beyond grade 6 the mean corneal astigmatism decreased to 2.12 diopters in the 7-9 grade group and 2.05 diopters in the 10-12 grade group.[28] Lyle with results similar to those obtained in earlier papers found differences do to age to be significant at the .05 level.[29]

As with corneal astigmatism, refractive astigmatism appears to decrease in amount and increase in prevalence with age in school children. Heard et al found a decrease in mean refractive astigmatism from 2.00 diopters in the kindergarten to sixth grade group to a more moderate 1.50 diopters in the seventh through twelfth graders.[30] Two diopters or more correctable refractive astigmatism was found in 45% of all second grade Navajo children examined by Abraham and Volovick. Only 17.0% of sixth graders and 9.0% of the twelfth graders had 2.00 diopters or more refractive astigmatism.[31] In observing the relationships between age and astigmatism Hamilton found that the percentage of Indian children with astigmatism increased with age from 27.7% in pre-kindergarten to 34.6% in grade twelve.[32] Morgan and Munro found no marked difference in refractive astigmatism due to age in their Indian and Eskimo populations.[33]

Comparisons between the corneal and refractive astigmatism found in younger Washington Indian children and older Washington Indian children show relationships similar to those found in other studies. The 0-9 group had a larger average amount of corneal and refractive astigmatism ($\bar{x}$ corneal = 1.00 diopters, $\bar{x}$ refractive = 0.71 diopters) than the 10-19 age group ($\bar{x}$ corneal = 0.87 diopters, $\bar{x}$ refractive = 0.52 diopters). Also, as in other studies, the prevalence of corneal astigmatism increased with age. The 0-9 age group had 74% of its population with 0.5 diopters

or more corneal astigmatism and the 10-19 age group had 81% of its population with 0.50 diopters or more corneal astigmatism. However, the prevalence of refractive astigmatism does not increase with age; 62.5% of the 0-9 age group had refractive astigmatism of 0.50 diopters or more, 51.7% of the 10-19 age group had refractive astigmatism of 0.50 diopters or more.

The age group averages for corneal and refractive astigmatism varied little from their total population means, with one exception. The 30-39 age group was affected by three patients with 5.00 diopters or greater astigmatism.

Sex:

Most previous studies found no difference in the prevalence of corneal and refractive astigmatism due to sex. Some differences were found, however, in the amount of astigmatism by sex. Lyle et al found that the Indian females had higher average corneal astigmatism than the Indian males, the females averaging 1.43 diopters, the males averaging 1.34 diopters. This difference was found to be significant at the .05 level.[34] Wick and Crane found the mean corneal and refractive astigmatism of males and females to be significantly different at the .03 and .02 levels respectively (mean corneal astigmatism: females = 1.63 D., males = 1.39 D.; mean refractive astigmatism: females = 1.20 D., males = 0.90 D.).[35]

Contrary to the above studies, the Washington Indians show no significant difference in the amount of corneal or refractive astigmatism by sex, even at the .05 level. The average male astigmatism was greater than the average female astigmatism in both corneal and refractive amounts. The males averaged 1.06 diopters of corneal astigmatism and 0.77 diopters of refractive astigmatism, the females averaged 0.95 diopters of corneal astigmatism and

0.67 diopters of refractive astigmatism.

Visual Acuity. Corrected visual acuity was better within the Washington Indian Population than in previous studies.

Wick and Crane's study of Sioux Indian children found lower visual acuities than expected, most likely due to the higher amounts of astigmatism.[36] Although Levy and Wall did not publish complete visual acuity results, they did note that a total of seven patients had less than 20/200 acuity with best correction.[37] According to Boniuk much of the Sioux Indian population did not obtain a visual acuity of 20/40 or better through the objective refraction. She felt that this was due mainly to cultural and language barriers. Contrary to the above, the Belcher Island Eskimos had 20/30 or better acuity in 79.6% of the cases. Females tended to have poorer visual acuities than males.[38] With the exception of the Belcher Island Eskimos, acuity levels were slightly lower than expected. The majority of the subjects had good functional acuity, but the best corrections did not improve acuity to the levels anticipated.

The acuity levels of the Washington Indians resembled the Belcher Island population, having 81.7% of the population with a habitual acuity level of 20/30 or better. With corrective lenses 95.0% of the total population reached the 20/30 level or better. The habitual acuities were not largely affected by age until 60 years and older, with acuity dropping drastically in the 70 years and older group.

Pathology. The prevalence of pathology in the Washington Indian population does not differ considerably from the previous Indian studies.

Wick and Crane detected pathology in 7.3% of the Sioux population compared to a 3.8% average for Caucasians. Blepharitis and

conjunctivitis were the most common ocular pathologies in the tribe.[39] Some form of ocular pathology was noted in 22.8% of the Canadian Siuox population. Pterygium was the most prevalent pathology followed by cataracts.[40] Fifty-two pathological conditions were detected by Woodruff and Samek, with some individuals exhibiting multiple pathologies. Out of the 52 pathological conditions detected 38 needed no treatment. Thus 10.1% of the total population required treatment.[41] These studies agree that pathology is more common in Indian populations than in Caucasian populations.

The Washington Indians examined exhibited the same amounts of pathology as the previously studied tribes. Pathological conditions were found in 31.6% of the population and several had multiple pathologies. Referral of patients for pathological conditions involved 10.7% of the population examined. Cataracts were the most commonly observed pathology.

Strabismus. The Washington Indian population exhibited a considerably lower prevalence of strabismus than previous studies.

The presence of strabismus was noted in two previous studies. Boniuk reported the presence of tropias in 4.0% of the Indian population.[42] The Belcher Island Eskimos study reported that 6.5% were strbismic.[43]

Strabismus was found in only 1.2% of the Washington Indians. Esotropia was found in 75.0% of all strabismic patients, exotropia comprised the remaining 25.0% of the strabismic patients.

Presbyopia. The prevalence of presbyopia for the Washington Indian population agrees with one of the two previous Indian studies for presbyopia, while disagreeing with the other.

Presbyopia of some degree was found in 95.5% of the Canadian Sioux

over age 40 studied by Boniuk.[44] Woodruff and Samek found that 29.1% of the Belcher Island Eskimos over 40 years old were presbyopic.[45] The percentage of subjects over age 40 found to be presbyopic varies greatly between the two studies.

Our study more closely resembles the results found by Boniuk. Exactly 92.0% of the Washington Indians over 40 years old were presbyopic. As expected, the percentage of subjects with presbyopia increased with age, starting with 2.2% of the 30-39 age group. By age sixty all patients were presbyopic.

Amblyopia. A lower prevalence of amblyopia was noted for the Washington Indian population than a previous Indian study.

Levy and Wall uncovered 30 cases of ambloyopia exanopsia in their study. In the 6-12 age group, 10.7% were amblyopic; in the 12-20 age group, 3.7%; and in the over 20 age group, 8.3%.[46]

Amblyopia was not nearly as prevalent in the Washington Indians as shown in the Levy and Wall study. Only two patients (0.6%) were amblyopic.

Phorias. Washington Indian children were less exophoric at far and near than the previous Indian study.

Wick and Crane found an average distance phoria of 1.44 prism diopters of exophoria in their study of Sioux Indian children. The same population had an average near phoria of 4.28 prism diopters of exophoria.[47]

The Washington Indian children showed average phorias of less divergence. At far the average phoria was 0.12 prism diopters of exophoria and at near (40 cm.) the average phoria was 3.57 prism diopters of exophoria.

CONCLUSIONS

The Washington Indian population tends to be slightly myopic as are most of the other Indian populations. The school age children tended to be more myopic than other studies. The prevalence of myopia is lower in the Washington Indian population than other Indian populations and appears to be lower than the general U.S. population.

The prevalence of hyperopia tended to be higher than either the other Indian populations or the general U.S. population.

This study supports the previous Indian studies, when comparing the prevalence of astigmatism in in Indian populations and the general U.S. population. The Washington Indians have a prevalence of astigmatism similar to other Indian populations and noticably higher than the general U.S. population. Though the prevalence of astigmatism is similar between the Washington Indians and other Indian populations, the Washington Indians have a lower average amount of astigmatism.

All Indian populations, including the Washington Indians, have a higher prevalence of ocular pathology than the U.S. population.

Acuity levels are approximately the same for all populations with functional vision as the criteria. Washington Indians and the U.S. population are able to achieve maximum acuities of 20/30 or better more frequently than other Indian populations, however.

Due to a lack of substantial information no definite conclusions can be drawn for the prevalence of presbyopia, amblyopia or strabismus.

Even with the addition of this study to the information bank there are still many areas which need to be explored before any final conclusions can be made about the visual status and needs for care of Indian groups. Further studies involving cross-sections of complete Indian populations need to be completed. Many studies

have been done on Indian children, but not on Indian adults.

It is difficult to compare this study to most of the studies of the general U.S. population due to differences in type of population and methods of information gathering. Therefore. a similar study involving a general population of clinic patients would be valuable for comparison to the Washington Indian population.

A P P E N D I X A

This section contains the forms which were used during information gathering : patient release form, standardized recording form, and computer processing form.

HSA-178
REV. 8-76

DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE

APPENDIX A-1

AUTHORIZATION FOR DISCLOSURE OF INFORMATION

(Pursuant to the Privacy Act of 1974 Public Law 93-579)

TO: DIRECTOR / MEDICAL OFFICER IN CHARGE

DATE

- ☐ U.S. PUBLIC HEALTH SERVICE HOSPITAL
- ☒ U.S. PUBLIC HEALTH SERVICE OUTPATIENT CLINIC
- ☐ U.S. PUBLIC HEALTH SERVICE HEALTH UNIT
- ☐ CONTRACT PHYSICIAN ☐ OTHER *(Specify)*

ADDRESS

Indian Health Service
Colville Indian Health Center
Nespelem, Washington 99155

You are hereby authorized to furnish information from my record in the medical *(indicate record system)* record system of your facility to:
(Print or type)

NAME OF APPLICANT *(Print or type)*

PERIOD OF TIME AUTHORIZATION COVERS

From: To:

IF INFORMATION IS FROM A MEDICAL RECORD, INDICATE WHETHER TREATMENT WAS AS A

☐ SEAMAN ☐ COAST GUARDSMAN ☐ FEDERAL EMPLOYEE ☒ OTHER *(Specify)*
Eligible Indian Health Service Beneficiary

EMPLOYER *(Specify)*

Not applicable

PLEASE SUPPLY INFORMATION ADEQUATE FOR:

☐ COMPENSATION CLAIM(S) ☐ SHIPPING COMPANY REPORT(S)

☐ INSURANCE CLAIM(S) ☐ ATTORNEY

☐ FURTHER MEDICAL CARE ☒ OTHER *(Specify)* Research Project

OTHER INFORMATION

I consent to the following:

The above named person may review my medical record for information concerning my medical history, examinations, and diagnostic tests that would be of value in research relating to eye conditions and diseases. However, I understand that the information obtained in this review will be used or displayed in the form of statistics only and that I will not be personally identified by name or any other method. Further, I understand that my refusal to sign this consent will not jeopardize or limit any benefits that I am otherwise elgible to recieve.

Any person who knowingly and willfully requests or obtains any record concerning an individual from an agency under false pretenses shall be guilty of a misdemeanor and fined not more than $5,000. (5 USC 552a(i)(2).

SIGNATURE OF APPLICANT

X [redacted]

IF OTHER THAN SUBJECT, INDICATE RELATIONSHIP OR AUTHORITY

ADDRESS OF APPLICANT *(Street and number, city, State, and zip code)*

APPENDIX A-2

CASE NUMBER_____ AGE_____ SEX_____ TRIBE_____

PATIENT'S COMPLAINTS_____

CLINICIAN OBSERVATIONS_____

PATHOLOGY? YES____ NO____ ICDA #_____ REFERRED? YES____ NO____

IF REFERRED, TO WHOM?_____

LOW VISION REFERRAL? YES____ NO____ OTHER REFERRALS? YES____ NO____

IF REFERRED FOR REASONS OTHER THAN ABOVE, TO WHOM?_____

THERAPY: RX-OD_____ VT-YES____ NO____ IF YES, CHECK TYPE:

OS_____ ____GENERAL BINOCULAR DYSFUNCTION

OTHER THERAPY_____ ____STRABISMUS

_____ ____AMBLYOPIA

_____ ____OTHER (DESCRIBE)_____

ENTRANCE ACUITIES

OD FAR____/____

NEAR____/____

OS FAR____/____

NEAR____/____

OU FAR____/____

NEAR____/____

FINAL RX ACUITIES

OD FAR____/____

NEAR____/____

OS FAR____/____

NEAR____/____

OU FAR____/____

K's OD____@____/____@____

OS____@____/____@____

#4 OD_____

OS_____

#7 OD_____

OS_____

#7a OD_____

OS_____

#8_____ #13b_____

#14b OD_____

#15b_____

OS_____

PRESBYOPIA? YES____ NO____

POWER OF ADD? OD_____ OS_____

DIRECTIONS

1. Write your name and number in the space provided.
2. While holding this sheet with the black marks toward you, mark your number in the appropriate squares. All three digits must be marked even though they may be zero.
3. Indicate your test answer with a mark over the letter. Make sure that this mark extends only between the two asterisks near the letter. A single stroke with a number two pencil is sufficient, darker or wider marks smudge and create subsequent problems. (See example) For a true/false test format, mark A/True and B/False.
4. Please note that only one answer can be marked in each column. Erase all stray marks completely and allow no marks to be made or erased in the black striped area at the bottom.

EXAMPLES

For Student No. 12

NAME Chek F-11

Questions

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50

A B C D E F G H I J

Student No.

0 1 2 3 4 5 6 7 8 9

PLEASE DO NOT MARK IN THIS AREA

A P P E N D I X B

The following data is a reduction of gross data from the information processed by the computer. This processed data, which included both left and right eye data, was reduced to right eye data only. Data was further reduced by combining the data from all three reservations into a single population called the Washington Indian population. this reduced data can be found in the following pages.

APPENDIX B-1a

#7a spherical component

	Males	Females	Total	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70 & up
-6.0	2	6	8	0	0	3	1	1	1	1	1
-5.0	3	5	8	0	0	5	1	1	0	0	1
-4.0	3	6	9	0	4	1	1	2	0	1	0
-3.0	5	13	18	0	4	5	4	5	0	0	0
-2.5	3	3	6	0	2	2	1	1	0	0	0
-2.0	3	6	9	0	2	3	3	1	0	0	0
-1.5	5	9	14	0	4	2	3	1	1	2	1
-1.0	10	14	24	1	10	5	2	3	2	0	1
-0.5	16	21	37	2	9	7	7	6	2	2	2
plano	45	58	103	11	37	18	9	14	7	3	4
+0.5	10	24	34	6	8	2	6	3	6	3	0
+1.0	7	13	20	1	3	1	2	2	5	4	2
+1.5	3	11	14	1	2	0	1	0	6	2	2
+2.0	0	5	5	0	1	0	0	0	0	3	1
+2.5	1	7	8	0	0	0	0	0	4	4	0
+3.0	6	4	10	1	0	1	2	1	0	1	4
+4.0	0	1	1	0	0	0	0	0	0	0	1
+5.0	1	1	2	0	1	0	1	0	0	0	0
+6.0	1	1	2	1	0	0	0	0	0	0	1
minus	40.3%	39.9%	40.1%	12.5%	40.2%	60.0%	52.3%	51.2%	17.6%	23.1%	28.6%
plano	36.3%	27.9%	31.0%	45.8%	42.5%	32.7%	20.4%	34.1%	20.6%	11.5%	19.0%
plus	23.4%	32.2%	28.9%	41.7%	17.3%	7.3%	27.3%	14.7%	61.8%	65.4%	52.4%
mean (D.)	-0.40	-0.41	-0.41	+0.52	-0.47	-1.45	-0.64	-1.92	+0.49	+0.52	+0.70
N	124	208	332	24	87	55	44	41	34	26	21

APPENDIX B-2a

#7a cylindrical component

	Males	Females	Total	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70 & up
0	41	76	117	9	42	18	12	13	14	5	4
0.5	47	70	117	9	30	20	13	20	10	10	5
1.0	12	35	47	2	5	11	5	4	6	8	6
1.5	8	11	19	1	4	3	5	1	2	1	2
2.0	6	4	10	0	2	1	2	0	1	0	4
2.5	5	2	7	2	1	0	2	1	0	1	0
3.0	1	1	2	0	0	1	0	0	1	0	0
3.5	0	3	3	0	0	1	1	0	0	1	0
4.0	1	3	4	1	2	0	1	0	0	0	0
4.5	0	1	1	0	1	0	0	0	0	0	0
5.0	2	2	4	0	0	0	2	2	0	0	0
5.5	0	0	0	0	0	0	0	0	0	0	0
6.0 &up	1	0	1	0	0	0	1	0	0	0	0
0-.99	71.0%	70.2%	70.5%	75.0%	82.8%	69.1%	56.8%	80.5%	70.6%	57.8%	42.9%
1.00-1.99	16.1%	22.1%	19.9%	12.5%	10.4%	25.5%	22.7%	12.2%	23.5%	34.6%	38.1%
2.00-3.00	9.7%	3.4%	5.7%	8.3%	3.4%	3.6%	9.1%	2.4%	5.9%	3.8%	0.0%
above 3.00	3.2%	4.3%	3.9%	4.2%	3.4%	1.8%	11.4%	4.9%	0.0%	3.8%	0.0%
mean (D.)	-0.77	-0.67	-0.71	-0.71	-0.52	-0.62	-1.19	-0.68	-0.56	-0.79	-0.93
N	124	208	332	24	87	55	44	41	34	26	21

APPENDIX B-2b

Cylindrical component of corrective lenses

	Total	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70 & up
Cylinder Rx	202	7	39	33	31	28	21	24	19
Spherical Rx	62	2	13	14	7	11	11	2	2
Cylinder Rx(%)	76.5%	78.0%	75.0%	70.2%	81.6%	71.8%	66.0%	92.0%	90.0%

APPENDIX B-3

Corneal Cylinder

	Males	Females	Total	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70 & up
- 0	18	38	56	7	15	6	4	10	7	6	1
0.5	36	60	96	7	30	15	8	11	9	9	7
1.0	30	43	73	4	21	10	16	9	7	4	2
1.5	13	23	36	4	5	15	4	1	4	0	3
2.0	5	13	18	3	4	4	4	2	1	0	0
2.5	3	1	4	0	2	0	1	1	0	0	0
3.0	1	2	3	1	1	0	0	0	0	1	0
3.5	1	3	4	1	2	0	0	0	1	0	0
4.0	3	4	7	0	1	2	3	1	0	0	0
4.5	0	0	0	0	0	0	0	0	0	0	0
5.0	1	1	2	0	0	0	1	1	0	0	0
5.5	1	1	2	0	0	0	1	0	0	1	0
6.0 &up	1	0	1	0	0	0	1	0	0	0	0
0-.99	47.8%	51.9%	50.3%	58.3%	55.6%	40.4%	27.9%	58.3%	55.3%	71.4%	61.5%
1.00-1.99	38.1%	34.9%	36.1%	33.3%	32.1%	48.1%	46.5%	27.8%	37.9%	19.0%	38.5%
2.00-3.00	8.0%	8.5%	8.3%	14.8%	8.6%	7.7%	11.7%	8.3%	3.4%	4.8%	0.0%
above 3.00	6.1%	4.7%	5.3%	3.6%	3.7%	3.8%	13.9%	5.6%	3.4%	4.8%	0.0%
mean (D.)	-1.06	-0.95	-0.99	-1.00	-0.87	-1.08	-1.51	-0.88	-0.79	-0.81	-0.77
N	113	189	302	27	81	52	43	36	29	21	13

APPENDIX B-5a

Habitual visual acuity at far

	Males	Females	Total	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70 & up
20/30 and above	112	170	282	31	70	45	39	38	31	19	9
20/40 to 20/60	9	26	35	2	7	3	3	2	2	5	11
20/70 or below	9	19	28	0	9	7	4	2	1	2	3
20/30 and above	86.2%	79.1%	81.7%	93,9%	81.4%	81.8%	84.8%	90.6%	91.2%	73.0%	39.1%
20/40 to 20/60	6.9%	12.1%	10.1%	6.1%	8.1%	5.5%	6.5%	4.7%	5.9%	19.2%	47.8%
20/70 or below	6.9%	8.8%	8.2%	0.0%	10.5%	12.7%	8.7%	4.7%	2.9%	7.8%	13.1%
N	130	215	345	33	86	55	46	42	34	26	23

APPENDIX B-5b

Habitual visual acuity at near

	Males	Females	Total	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70 & up
20/30 and above	113	174	287	31	84	52	42	31	22	18	7
20/40 to 20/60	14	31	42	2	2	3	3	8	10	4	13
20/70 or below	3	10	13	0	0	0	1	3	2	4	3
20/30 and above	86.9%	80.9%	83.2%	93.9%	97.7%	94.6%	91.3%	73.8%	64.7%	69.2%	30.4%
20/40 to 20/60	10.8%	14.4%	12.1%	6.1%	2.3%	5.4%	6.5%	19.0%	29.4%	15.4%	56.5%
20/70 or below	2.3%	4.7%	3.7%	0.0%	0.0%	0.0%	2.2%	7.2%	5.9%	15.4%	13.1%

APPENDIX B-7a

Phorias at far

	Males	Females	Total	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70 & up
ø	77	127	204	12	55	34	29	25	26	15	8
2xo-6xo	13	37	50	2	15	12	7	7	5	2	0
2so-6so	16	22	38	3	11	6	5	6	1	5	1
ø	72.6%	68.3%	69.9%	70.6%	67.9%	65.4%	70.7%	65.8%	81.3%	68.2%	88.9%
2xo-6xo	12.3%	19.9%	17.1%	11.8%	18.5%	23.1%	17.1%	18.4%	15.6%	9.1%	0.0%
2so-6so	15.1%	11.8%	13.0%	17.6%	13.6%	11.5%	12.2%	15.8%	3.1%	22.7%	11.1%
mean	0.09xo	0.09xo	0.09xo	.11x	.12x	.27x	.39x	ø	.19x	.36s	.22s
N	106	186	292	17	81	52	41	38	32	22	9

APPENDIX B-7b

Phorias at near

	Males	Females	Total	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70 & up
ø	3	11	14	2	7	2	2	0	1	0	0
2xo-6xo	64	114	178	14	55	30	26	25	13	8	7
over 6xo	31	53	84	0	12	17	14	11	17	12	1
2so-6so	4	9	13	1	5	1	2	2	1	1	0
over 6so	0	4	4	0	2	2	0	0	0	0	0
ø	2.9%	5.8%	4.8%	11.8%	8.6%	3.8%	4.5%	0.0%	3.1%	0.0%	0.0%
2xo-6xo	62.7%	59.7%	60.7%	82.4%	67.9%	57.8%	59.1%	65.8%	40.6%	38.1%	87.5%
over 6xo	30.5%	27.7%	28.7%	0.0%	14.8%	32.7%	31.9%	28.9%	53.2%	57.1%	12.5%
2so-6so	3.9%	4.7%	4.4%	5.8%	6.2%	1.9%	4.5%	5.3%	3.1%	4.8%	0.0%
over 6so	0.0%	2.1%	1.4%	0.0%	2.5%	3.8%	0.0%	0.0%	0.0%	0.0%	0.0%
mean	5.21x	5.21x	5.21x	2.35x	4.02x	5.27x	5.77x	5.74x	7.00x	7.14x	5.00x
N	102	191	293	17	81	52	44	38	32	21	8

APPENDIX B-8

Presbyopia

	Males	Females	Total	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70 & up
Yes	---	---	116	0	0	0	1	33	33	26	23
No	---	---	229	33	86	55	45	9	1	0	0
Yes	---	---	33.6%	0.0%	0.0%	0.0%	2.2%	78.6%	97.1%	100%	100%
No	---	---	66.4%	100%	100%	100%	97.8%	21.4%	2.9%	0.0%	0.0%

N=345

APPENDIX B-9

Therapy

	Males	Females	Total	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70 & up
New Rx	42	47	89	8	32	14	10	14	9	0	2
Change Rx	27	50	77	1	4	11	5	16	15	17	8
Replace Rx	14	28	42	0	9	13	10	5	1	2	2
No Rx Change	14	42	56	0	7	9	13	4	7	7	9
No Rx Needed	33	48	81	24	34	8	8	3	2	0	2
New Rx	32.3%	21.9%	25.8%	24.2%	37.2%	25.5%	21.7%	33.3%	26.5%	0.0%	8.7%
Change Rx	20.8%	23.3%	22.3%	3.0%	4.7%	20.0%	10.9%	38.1%	44.1%	65.4%	34.8%
Replace Rx	10.8%	13.0%	12.2%	0.0%	10.5%	23.6%	21.7%	11.9%	2.9%	7.7%	8.7%
No Rx Change	10.8%	19.5%	16.2%	0.0%	8.1%	16.4%	28.3%	9.5%	20.6%	26.9%	39.1%
No Rx Needed	25.3%	22.3%	23.5%	72.8%	39.5%	14.5%	17.4%	7.1%	5.9%	0.0%	8.7%
N	130	215	345	33	86	55	46	42	34	26	23

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