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VITAL and HEALTH STATISTICS

DATA FROM THE NATIONAL HEALTH SURVEY

Binocular Visual Acuity of Adults

United States - 1960 - 1962

Vision testing methods and binocular visual acuity findings, by age, sex, and race among adults aged 18–79 years.

Washington, D.C. June 1964

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
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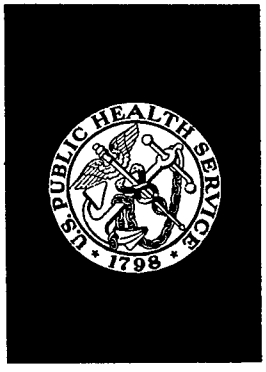

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BINOCULAR VISUAL ACUITY OF ADULTS

Jean Roberts, *Division of Health Examination Statistics*

INTRODUCTION

This is one in the series of reports describing and analyzing the plan, conduct, and findings of the first cycle of the Health Examination Survey. This report presents the Survey results for binocular visual acuity.

The Health Examination Survey from which these data derive was organized as part of the National Health Survey to obtain statistics on the health status of the population of the United States through direct examination.

The plan and initial program of the Health Examination Survey have already been recounted in substantial detail.[1] A first report on the survey findings described the demographic composition of the sample, the possible effects of nonresponse on the findings, and the inflation process used to convert examination findings into estimates for the adult population of the United States from which the sample was drawn.[2]

In this first cycle, the Health Examination Survey concentrated on the collection of statistics for certain of the more prevalent chronic diseases and on selected physical and physiological measurements among the adult civilian, noninstitutional population of the United States 18 through 79 years of age. This phase of the Survey was started in October 1959 and completed in December 1962. Out of the defined sample of 7,710 persons, 6,672 (or more than 85 percent) were examined.

A standardized single-visit examination was given each examinee by medical and other staff members in the specially designed mobile units used for the Survey. Prior to the examination, data comparable to those collected by the Health Interview Survey were obtained from the households of the sample persons. In most of the sample households, every second eligible adult was chosen for the examination.

Previous reports indicate that no major feature of the adult population of the United States can be said to be seriously distorted in the sample and that the effects of nonresponse on the demographic picture are apparently not serious.[2]

Fewer visual defects were reported on interview among the nonexamined part of the sample than expected if the prevalence rate of such defects in the examined and nonexamined groups were actually the same. On that assumption, these defects were underreported by about 16 percent for the nonexamined group. If the same differential exists for severely defective vision and other eye conditions obtained from the examination, then the survey estimates for the total will overstate the true prevalence figures by only 2 percent.

VISUAL EXAMINATION

Central visual acuity for distance and for near vision was measured for each examinee as part of the standardized examination in the first cycle of the Health Examination Survey. In addition the Survey staff physician recorded any gross defects found during the limited examination of the eye. These physical findings together with the medical history and household interview information for the examinee constitute the data on vision available from this cycle of the Survey.

These data on visual acuity are the first to be collected for a national probability sample of the adult population in the United States. Previous

surveys have been limited to information obtained on interview or from testing of specific population groups such as insurance policy holders, employees of large industries, or those in certain geographic areas.

This report contains estimates of the levels of binocular distance and near visual acuity by age, sex, and race. Results are given for tests with and without corrective lenses in the following two forms:

1. "uncorrected" or "unaided" acuity refers to the scores attained without glasses or other corrective lenses, and
2. "corrected" acuity refers to scores attained with corrective lenses for persons tested with their glasses together with scores without correction for those tested only without glasses either because they did not bring them to the examination or do not wear them.

The Testing Instrument

Space and time limitations for the examination were determining factors in selecting a commercial instrument, the Sight-Screener, for testing visual acuity in the Survey. This device, shown in figure 1, uses the stereoscopic principle to achieve the optical equivalent of 20 feet for testing at distance. Near vision is tested at 14 inches without the interpositioning of lenses. Monocular acuity is measured under conditions of binocular seeing with the examinee unaware of which eye is being tested.

The Sight-Screener allows for rapid testing under controlled conditions of lighting and target distance from the examinee. The effective illumination on the target and the contrast between target letters and background were maintained within the optimum limits for such tests.[3]

The acuity target contains three lines differing only in the sequence of the letters—one line each for testing the right eye, the left eye, and binocular vision. Targets for the optical equivalent of distance and for near vision were identical. The letters are arranged in blocks or steps of from one to four letters. The size of the letters becomes progressively smaller from one block to the next when reading from left to right. The unserifed letters of the target follow the Snellen principle with their height as well as their width being five times the width of the lines in the letters.

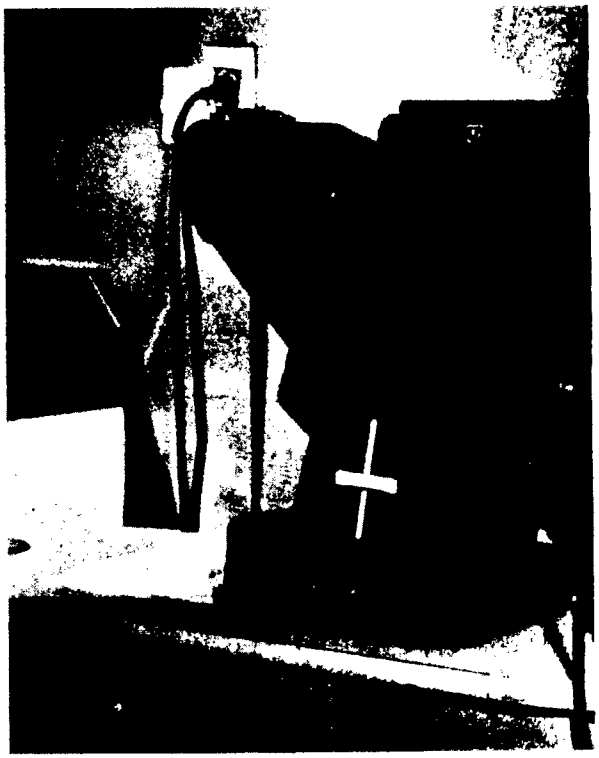

Figure 1. The Sight-Screener.

Like similar commercial devices the Sight-Screener is designed for screening purposes—for pass or fail at certain critical levels. It does not measure as accurately across the entire range of vision as would be possible with a good wall chart or cards. The acuity scale on the target is coarse at the poorer levels from 20/200 to 20/50 with only four steps and few letters, while at levels critical to qualification (i.e., for service in the Armed Forces or for certain types of civilian employment or licenses—20/50 through 20/10), there are five steps with four letters at each level. The testing levels on the targets were as follows:

Distance—20/200, 20/100, 20/70, 20/50, 20/40, 20/30, 20/20, 20/15, 20/10.

Near—14/140, 14/70, 14/49, 14/35, 14/28, 14/21, 14/14, 14/10.5, 14/7.

Despite these limitations, test results on the Sight-Screener and on Sloan Charts[4] (an improved Snellen-type) were found to be in good

agreement, although slightly lower on the former because of the coarser scale at the poorer acuity levels.[5]

Testing Methods

Right eye, left eye, and binocular vision were always tested in that order. However, the sequence of near and distance tests was alternated for successive examinees—the first started with near tests, the second with the distance tests. Test order was so randomized as to minimize any consistent bias for either test series due to fatigue, practice, or learning of target letters. The methodological study gave no indication that these factors had a demonstrable effect in test results.

To "pass" or be able to read at a particular level no errors were allowed if the block contained fewer than four letters and only one error in steps of four letters. The visual acuity level or "score" for an examinee is that which corresponds to the smallest letters he was able to read with no more than the allowable number of errors.

Quality Control

After joining the examining staff, each of the five dentists employed during the cycle was given training and practice in vision testing techniques to insure the consistency of test results. Further practice in testing was obtained during the "dry run" examinations which preceded the start of the regular examinations at each of the 42 areas in which the mobile Health Examination Centers were located.

During the survey, two of the examining dentists carried out a pretest with a group of 144 boys at the National Training School for Boys both to assess the effect of the standard dental light on the vision test scores and to determine the comparability of their vision test results. The group was tested by both dentists, half before the dental examination and half immediately afterward. The pretest gave no indication that exposure to the dental light prior to the vision test affected the acuity scores. Hence, it was assumed that testing of vision immediately after the dental examination, as was done throughout this survey, did not appreciably affect visual acuity scores. Acuity test results obtained by the two dental examiners were also found to be in good agreement. Comparison of results obtained by each tester at the stand locations further indicate that testing had remained consistent throughout the cycle. The proportion rated as having normal or better vision showed essentially no differences attributable to the testers when the age-sex differences among examinees at the various stands were removed.

FINDINGS

Uncorrected Distance Visual Acuity

Health Examination Survey findings indicate that more than half (54 percent) of the civilian, noninstitutional population of the United States aged 18 through 79 years have at least normal central binocular visual acuity at distance when tested without corrective lenses as shown in tables A, 1, and 2. About 30 percent have better than normal vision, attaining levels of 20/15 or 20/10 in Snellen notation ("normal" distance vision in this notation is generally considered to be 20/20).

The median unaided visual acuity is at the 20/19 level. Hence, half of the adult population are able to read at 20 feet letters of a size that persons with normal vision could be expected to read at 19 feet.

One-fourth of the adults have moderately defective vision without glasses, reading at best

Table A. Proportion reaching or exceeding the test levels for distance vision: United States, 1960-62

Test level	Proportion for distance vision	
	Uncorrected	"Corrected"
20/10 or better--	1.1	1.5
20/15 or better--	30.3	40.0
20/20 or better--	53.9	72.9
20/30 or better--	69.3	90.6
20/40 or better--	75.8	95.1
20/50 or better--	80.4	96.8
20/70 or better--	83.9	97.7
20/100 or better-	93.5	99.2
20/200 or better-	97.6	99.6

no further than the 20/30, 20/40, or 20/50 level. The majority of these persons (15 percent) score just short of normal, at the 20/30 level.

The remaining one-fifth of the adults test at the 20/70 level or less. Included with this latter group are an estimated 2.6 million or 2 percent who have binocular distance acuity of less than 20/200.

"Corrected" Distance Vision

As used in this report, "corrected" vision denotes functional acuity or the level at which the adults are actually seeing with whatever correction they are using.

Forty-four percent of the examinees were tested at distance with and without their glasses. This represents essentially all persons who stated they wore glasses for distance vision. Glasses improved acuity for 76 percent while 19 percent tested the same with glasses as without, and 5 percent did better without their glasses. A few of this latter group were inadvertently tested at distance with refraction intended for near vision.

The remaining 56 percent of the examinees tested at distance only without glasses had acuity scores distributed over the entire test range. Substantially more of them had at least normal vision than was true for persons with glasses (when tested without correction)—76 percent compared with 30 percent.

The resultant improvement in acuities with correction is clearly evident in tables A, 3, and 4, particularly for those with defective, unaided vision of 20/70 or better.

Survey findings as shown indicate that nearly three-fourths (73 percent) of the adult population have normal or above normal vision with whatever correction they are using. The median score was 20/16.5 compared with 20/19 for uncorrected acuity.

Over 90 percent reached the 20/30 level or better with "correction" compared with 69 percent for unaided vision.

The proportion unable to read at the 20/200 level (0.4 percent) is too small to give a reliable estimate for this segment of the population. Yet it can be said with a fair degree of certainty that the actual proportion in the adult population probably does not exceed 1 percent. This group will include the legally blind as well as those whose vision could be corrected to normal or near normal. However, neither the testing nor the examination procedures in this cycle were sufficient to provide the basis for making a more precise estimate of the prevalence of blindness.

Near Vision

Near acuity, both "corrected" and uncorrected, was more deficient among these adults than their distance vision—a finding to be expected because of the known physiological effects of aging on the normal eye. In *May's Manual of the Diseases of the Eye*[6] it is stated that the power of accommodation needed to bring near objects into clear focus gradually diminishes with age, due chiefly to loss of elasticity of the lens. The physiological change becomes most pronounced when nearing the age of 45. Distance vision is not similarly affected.

Forty-five percent had at least normal unaided near vision and 63 percent tested at the 14/35 level or better (tables B and 5-8) as compared with the 54 percent and 80 percent reaching similar levels at distance without refraction (table A). (Normal near vision in Snellen notation as used here is generally considered to be 14/14.)

Over half of the examinees (52 percent) were tested both with and without glasses for near vision. (An additional 4 percent stated they wore

Table B. Proportion reaching or exceeding the test levels for near vision: United States, 1960-62

Test level	Proportion for near vision	
	Uncorrected	"Corrected"
14/7 or better---	1.0	1.1
14/10.5 or better	24.0	29.8
14/14 or better--	44.7	64.9
14/21 or better--	53.6	84.7
14/28 or better--	58.3	90.9
14/35 or better--	62.7	93.7
14/49 or better--	68.2	95.6
14/70 or better--	83.9	98.6
14/140 or better-	95.7	99.6

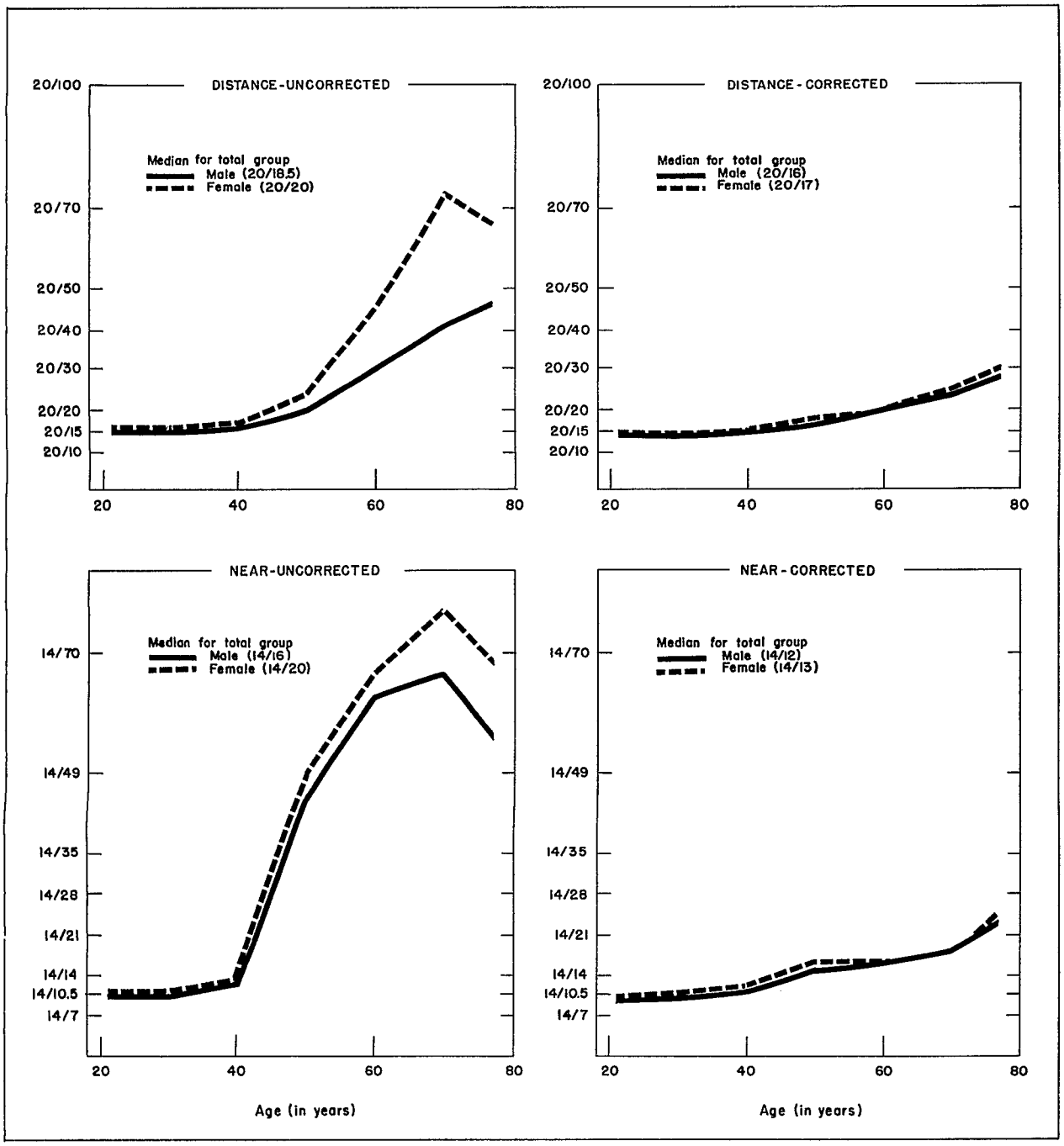

Figure 2. Median binocular acuity among adults, by age and sex.

glasses for near work but did not bring them to the examining center.) Of those tested with glasses or contact lenses, 83 percent had improved acuities with correction, 14 percent were unchanged, and 3 percent did less well with than without their glasses.

As for distance vision, substantially more of those tested only without correction had at least normal unaided near vision—74 percent compared with 30 percent for those with glasses when tested without them.

With "correction," as defined for this report, 65 percent reached at least the normal level of 14/14 or better—10 percent less than for "corrected" distance vision.

Age-Sex Differences

Survey findings show relatively better unaided distance and near vision for men than for women. With "correction," the differences are essentially eliminated (fig. 2).

Significant differences are evident at the extremes of the range, accounting for the divergent medians shown in the charts. More men than women exceeded normal, testing without correction at 20/15 or 20/10 for distance and 14/10.5 or 14/7 for near. Conversely, women outnumbered men at the poorer levels of 20/70 or less and 14/49 or less (tables 1 and 3).

The decline of acuity with age is clearly evident in these charts for both men and women. The proportion with at least normal vision starts dropping rapidly after 45 years of age, with the percentage of men at this level exceeding women in each age group.

With distance vision, the proportion testing normal or better without correction falls from 70 percent for men and women under 45 years of age to less than 10 percent for those 65 years and over. A similar pattern is evident in the "corrected" scores.

The regression with age started a little earlier (between 35 and 44 years) in uncorrected near vision. Here, a more precipitous decline was found than for distance, and few persons over age 55 were able to attain normal vision without correction.

At the other extreme (20/70 or less), the proportion with poorer distance acuity increases with age and remains consistently greater for women than men. Less than 10 percent have such defective vision under the age of 45, while by the age of 65 more than 35 percent of the men and over 50 percent of the women tested no better than 20/70 without glasses.

Near vision scores show an abrupt change between ages 35 and 45. In this age span, the proportion with no better than 14/49 vision accelerates from less than 15 percent to about 60 percent for both men and women. The sex difference by age was less pronounced for near than for distance vision.

Racial Differences

Comparisons are limited here to acuity findings for Negro and white persons since the sample was too small to allow for adequate representation of other nonwhite races.

No consistent racial differences were found in the prevalence of normal or better unaided vision either at distance or near as shown in tables C and D. The median scores attained by Negro and white persons are also similar throughout the age range for both men and women.

If the lower extreme of the range of distance vision is considered, then white men and women would be found to have relatively more with poor distance vision (20/70 or less) at each age—the pattern more pronounced for men than women as evident in figure 3. A similar trend does not exist for near vision. On these latter tests the proportion of white males with such defects exceeded Negro males at 25-34 and 55-79 years, while among women an excess of Negroes was found at 45-54 and an excess of whites at 65-79 years.

No such consistent pattern may be seen at the normal end of the range. Moreover, there are noticeable dissimilarities between men and women in what trend does exist. Relatively more white than Negro men ages 18-24 and 35-44 years have at least normal distance vision, while Negro men are in excess at ages 25-34, 45-54, and 65-79 (fig. 4). Among women with normal distance vision, there are a disproportionate number of white women ages 25-34 and 45-64, while more Negro women than would be expected were found in the ages 18-24 and 65-79.

Racial differences are less marked and even less consistent for near unaided vision.

Table C. Distribution of adults reaching or exceeding specified acuity levels for uncorrected binocular distant vision, by sex, age, and race: United States, 1960-62

Sex and age	Acuity level					
	20/20 or better		20/50 or better		20/200 or better	
	White	Negro	White	Negro	White	Negro
Men						
Total-18-79 years	57.3	59.9	83.7	93.2	98.5	99.1
18-24 years	80.2	75.4	92.2	97.8	98.8	100.0
25-34 years	79.5	85.6	90.4	98.5	99.1	100.0
35-44 years	80.5	76.1	93.4	94.4	99.3	98.2
45-54 years	49.5	55.7	85.9	97.4	99.1	100.0
55-64 years	25.1	23.0	72.0	84.9	98.1	98.1
65-74 years	8.8	15.3	58.4	74.6	95.7	100.0
75-79 years	1.3	-	53.1	78.8	93.2	91.3
Women						
Total-18-79 years	50.4	52.9	75.5	84.5	96.9	96.3
18-24 years	71.3	78.9	88.0	96.3	97.4	100.0
25-34 years	76.2	71.5	90.6	93.4	96.6	97.0
35-44 years	74.1	73.4	91.5	96.0	98.3	99.3
45-54 years	40.6	27.7	76.9	81.7	98.0	95.7
55-64 years	17.8	12.8	53.3	56.1	98.4	90.6
65-74 years	2.4	10.2	38.7	50.5	91.1	89.4
75-79 years	1.8	-	30.4	58.7	91.0	87.3

Corrected acuities were significantly better for whites than Negroes among both men and women on distance and near vision. On distance tests, 74 percent of the whites as compared with 62 percent of the Negroes rated normal or better with their "corrected" vision. Scores with "corrected" vision or near tests were normal or better for 66 percent of the whites as compared with 53 percent of the Negroes. The proportion with at least normal vision among whites exceeded Negroes at each age for distance and from 35 years on for near vision.

COMPARISON WITH OTHER STUDIES

While many surveys have been undertaken in which a determination of the distribution of visual acuity was attempted, they have all been limited to selected groups of the population—industrial employees, life insurance policy holders, selected groups of older persons, and Armed Forces personnel, to mention a few. In addition, measurement techniques used in the various studies differ.

The present survey is the first in which measurements of visual acuity were obtained for a probability sample of the entire adult civilian, noninstitutional population of the United States under the age of 80. As indicated, testing was done under as near optimum conditions of target illumination, end-point or scoring criteria, and target distance as possible. The methodological study showed that with the survey methods used, the scores attained on the Sight-Screener were in general comparable to those obtained on Sloan Charts (an improved Snellen-type chart).[5]

Table D. Distribution of adults reaching or exceeding specified acuity levels for uncorrected binocular near vision, by sex, age, and race: United States, 1960-62

Sex and age	Acuity level					
	14/14 or better		14/35 or better		14/140 or better	
	White	Negro	White	Negro	White	Negro
Men						
Total-18-79 years	47.4	47.7	63.5	67.6	96.5	97.4
18-24 years	87.5	89.3	96.3	100.0	99.5	100.0
25-34 years	85.9	93.7	94.0	98.5	99.5	100.0
35-44 years	74.9	76.3	93.4	94.4	99.7	99.2
45-54 years	13.2	3.4	40.9	36.2	97.5	98.1
55-64 years	0.9	-	16.7	25.6	92.2	96.5
65-74 years	-	-	14.0	25.6	86.0	85.1
75-79 years	7.6	-	27.8	40.2	86.8	78.8
Women						
Total-18-79 years	41.7	45.6	60.6	65.7	94.9	94.3
18-24 years	79.4	85.7	96.0	99.0	99.5	100.0
25-34 years	82.8	72.9	95.0	93.7	99.1	98.0
35-44 years	63.3	63.0	86.7	85.8	99.3	99.3
45-54 years	7.3	4.7	37.3	32.5	95.1	89.8
55-64 years	0.8	-	15.8	12.7	89.9	89.5
65-74 years	-	-	13.3	20.0	81.7	77.8
75-79 years	-	-	9.8	9.1	83.3	72.3

Comparison is made here with findings from a few of the larger studies.

Hirsch[7] obtained measurements of visual acuity on nearly 1,700 persons age 40 through 80 and over in a sample selected from private practice in a small urban-rural California community supplemented by some 50 blind pensioners and other patients with subnormal vision. Roughly 200 persons were included for each of the seven 5-year age groups from 40 through 74 and about 130 in each of the older age groups—75-79 and 80 and over. Published reports do not describe the testing techniques in detail, but apparently Snellen-type charts were used in determining the best corrected distance vision. As indicated below the acuities obtained for Hirsch's series are substantially better than those from the National Health Examination Survey:

Acuity level	Data of Hirsch (45-79 years)	HES data "Corrected" acuities (45-79 years)
	Percent distribution	
20/20 or better	73	53
20/30 to 20/50	20	41
20/70 or less	7	6

This difference would be expected since the present survey obtained acuities with the examinee's present correction whereas the patients

from private practice were tested with the best possible refraction.

Wilson and McCormick[8] obtained the proportion with corrected acuities of less than 20/40 in each eye for over 10,000 employees of the B.F. Goodrich Company ranging in age from under 21 to over 60 years. As in the present survey, the Sight-Screener instrument was used for testing. In the Goodrich study 29 percent of the men and 23 percent of the women tested less than 20/40.

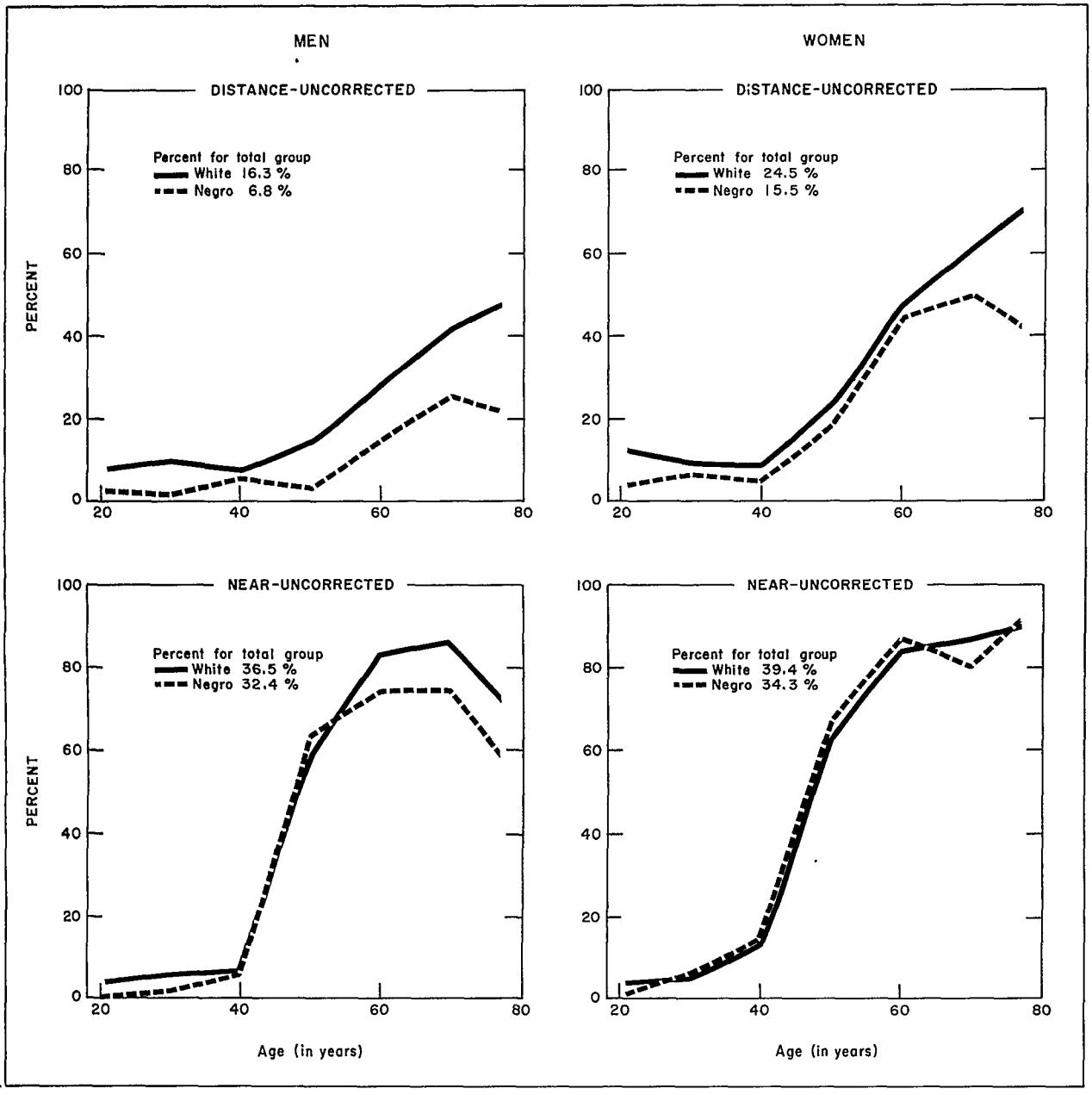

Figure 3. Percent of adults with 20/70 or less (or 14/49 or less) binocular acuity, by age, sex, and race.

Present survey findings show only 5 percent of both men and women of this age range unable to reach that level with "correction." Even when comparison is made with monocular acuity scores, Health Examination Survey findings for the entire adult population show substantially better acuities in general than were found among Goodrich employees. More restrictive scoring criteria in the industrial survey may account for part of this difference.

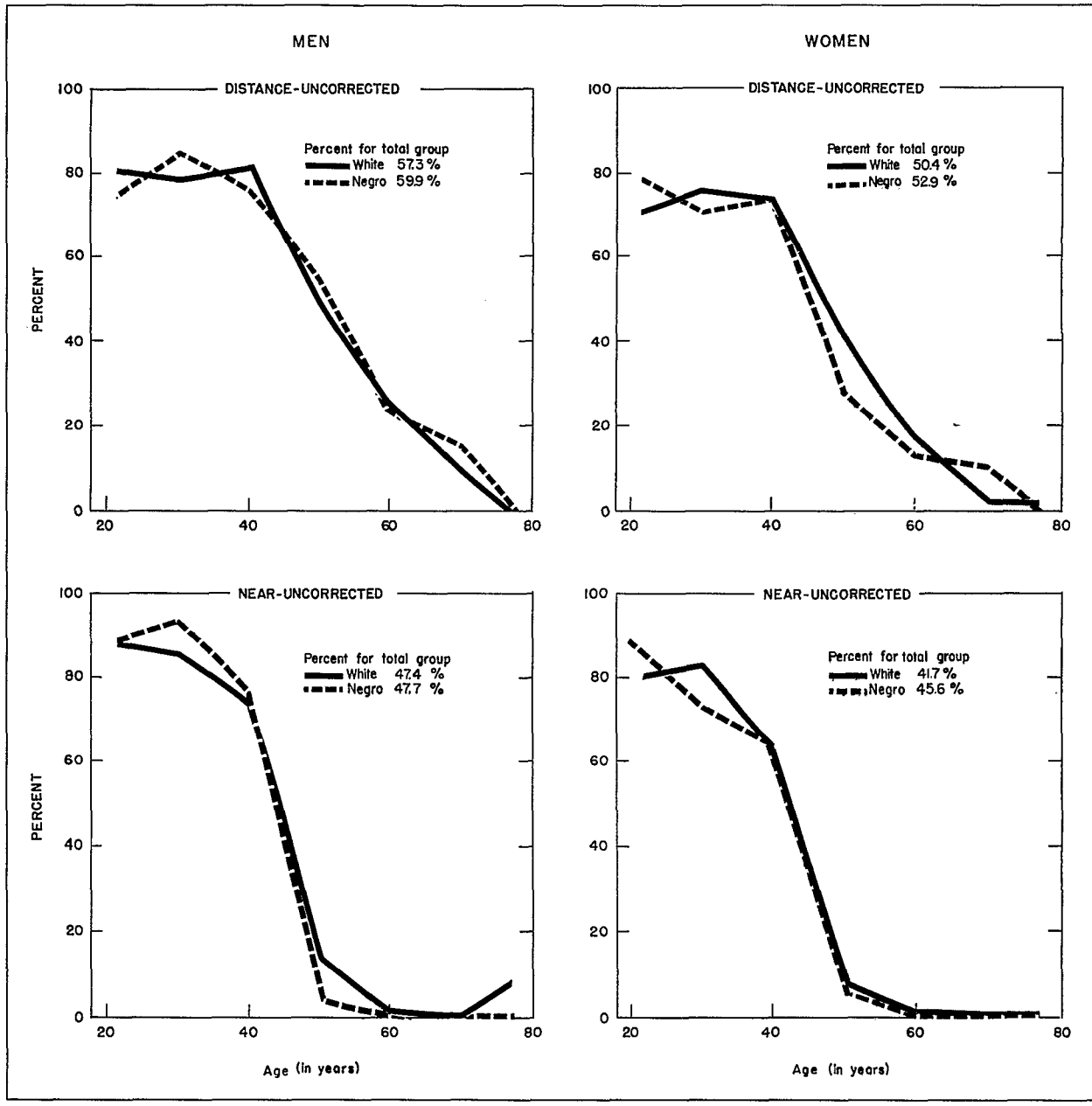

Figure 4. Percent of adults with at least normal binocular visual acuity (20/20 or better on distance and 14/14 or better for near) by age, sex, and race.

Collins and Pennell[9] reported on the extent of defective vision (less than 20/20 among 112,000 white life insurance policy holders. He found that 45 percent at ages 30-34 did not obtain 20/20 with each eye and that the percentage increases most rapidly at about age 45, then tends to level off at about 80 percent at age 60. A different pattern may be seen in the current survey findings. Here only 25 percent of those aged 30-34 tested less than 20/20 without correction, and the percentage continues to increase steadily from ages 45 through 79 with no leveling off near age 60. If comparison was made with monocular findings from the present survey, the differences in the percentages at ages 30-34 would have been reduced somewhat. However, this would not account for the dissimilar trends with age.

In his analysis of racial differences for visual acuity among 273,000 Selective Service registrants in 1957 and 1958, Karpinos[10] found better vision for Negroes than whites, in contrast with the findings from the present survey as indicated below:

Acuity level	Karpinos' number per 1,000 male examiness 18-26 years (in at least one eye)	
	White	Negro
20/20 or better	780	888
20/50 or better	889	969
20/200 or better	961	993

Acuity level	HES number per 1,000 male examinees (binocular vision)			
	(18-24 yrs.)		(25-34 yrs.)	
	White	Negro	White	Negro
20/20 or better	802	754	795	856
20/50 or better	922	978	904	985
20/200 or better	988	1,000	991	1,000

It is apparent that if acuities from the present survey were tabulated for ages 18-26 there would be less difference between the two races, and the proportion with at least normal vision among the Negroes would not exceed that for the whites.

SUMMARY

Health Examination Survey results from testing visual acuity show that among the United States civilian, noninstitutional population aged 18 through 79 years:

1. Over half have normal or better distance vision without correction and more than three-fourths with whatever refraction they were using at the time of the survey.
2. Near vision tends to be more deficient than distance vision, as expected because of the known physiological effects of aging on the normal eye.
3. Men have better unaided vision than women at both distance and near.
4. Visual acuity declines with age from about 45 years on, with the percentage of men with normal or better vision exceeding women throughout the age range.
5. Regression with age starts a little earlier with near than with distance vision.
6. No consistent racial differences were found in the prevalence of normal or better unaided vision either at distance or near for men or women throughout the age range. However, corrected near and distance acuities were significantly better for white men and women than for Negro men and women.

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DETAILED TABLES

Table 1. Number of adults reaching specified acuity levels for uncorrected distance vision, by age and sex: United States, 1960-62

Sex and acuity level	Total, 18-79 years	18-24 years	25-34 years	35-44 years	45-54 years	55-64 years	65-74 years	75-79 years
Both sexes	Number of adults in thousands							
Total	111,087	15,569	21,572	23,698	20,576	15,637	11,164	2,871
20/10 or better	1,236	277	460	356	143	-	-	-
20/15	32,286	7,516	10,364	10,043	3,603	658	102	-
20/20	26,168	3,847	5,871	7,800	5,440	2,627	541	42
20/30	17,080	1,623	2,077	2,576	4,851	3,418	2,160	375
20/40	7,298	567	534	743	1,606	1,852	1,490	506
20/50	5,125	292	319	455	1,294	1,302	1,110	353
20/70	3,898	163	337	349	788	1,106	767	388
20/100	10,742	560	605	653	1,758	3,153	3,208	805
20/200	4,592	465	507	446	777	1,200	1,025	172
Less than 20/200	2,662	259	498	277	316	321	761	230
Men								
Total	52,744	7,139	10,281	11,373	10,034	7,517	4,972	1,428
20/10 or better	764	126	332	199	107	-	-	-
20/15	17,792	3,975	5,489	5,577	2,305	387	59	-
20/20	11,771	1,576	2,376	3,292	2,630	1,477	402	18
20/30	8,185	674	765	995	2,296	2,039	1,164	252
20/40	3,658	197	231	341	849	881	802	357
20/50	2,432	92	156	220	568	706	531	159
20/70	1,673	83	173	182	332	474	347	82
20/100	4,159	186	383	314	586	1,116	1,145	429
20/200	1,495	157	245	165	279	297	321	31
Less than 20/200	815	73	131	88	82	140	201	100
Women								
Total	58,343	8,430	11,291	12,325	10,542	8,120	6,192	1,443
20/10 or better	472	151	128	157	36	-	-	-
20/15	14,494	3,541	4,875	4,466	1,298	271	43	-
20/20	14,397	2,271	3,495	4,508	2,810	1,150	139	24
20/30	8,895	949	1,312	1,581	2,555	1,379	996	123
20/40	3,640	370	303	402	757	971	688	149
20/50	2,693	200	163	235	726	596	579	194
20/70	2,225	80	164	167	456	632	420	306
20/100	6,583	374	222	339	1,172	2,037	2,063	376
20/200	3,097	308	262	281	498	903	704	141
Less than 20/200	1,847	186	367	189	234	181	560	130

Table 2. Percent distribution of adults reaching specified acuity levels for uncorrected distance vision, by age and sex: United States, 1960-62

Sex and acuity level	Total, 18-79 years	18-24 years	25-34 years	35-44 years	45-54 years	55-64 years	65-74 years	75-79 years
	Percent distribution							
Both sexes								
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
20/10 or better	1.1	1.8	2.1	1.5	0.7	-	-	-
20/15	29.2	48.3	48.0	42.3	17.5	4.2	0.9	-
20/20	23.6	24.7	27.2	32.9	26.4	16.8	4.8	1.5
20/30	15.4	10.4	9.6	10.9	23.7	21.8	19.3	13.1
20/40	6.5	3.6	2.5	3.1	7.8	11.8	13.3	17.6
20/50	4.6	1.9	1.5	1.9	6.3	8.3	9.9	12.3
20/70	3.5	1.0	1.6	1.5	3.8	7.1	6.9	13.5
20/100	9.6	3.6	2.8	2.8	8.5	20.2	28.9	28.0
20/200	4.1	3.0	2.4	1.9	3.8	7.7	9.2	6.0
Less than 20/200	2.4	1.7	2.3	1.2	1.5	2.1	6.8	8.0
Men								
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
20/10 or better	1.4	1.8	3.2	1.7	1.1	-	-	-
20/15	33.9	55.6	53.5	49.0	23.0	5.1	1.2	-
20/20	22.4	22.1	23.1	29.0	26.1	19.6	8.1	1.2
20/30	15.5	9.4	7.4	8.8	22.9	27.2	23.4	17.6
20/40	6.9	2.8	2.2	3.0	8.5	11.7	16.1	25.0
20/50	4.6	1.3	1.5	1.9	5.7	9.4	10.7	11.1
20/70	3.2	1.2	1.7	1.6	3.3	6.3	7.0	5.8
20/100	7.8	2.6	3.7	2.8	5.8	14.8	23.0	30.1
20/200	2.8	2.2	2.4	1.4	2.8	4.0	6.5	2.2
Less than 20/200	1.5	1.0	1.3	0.8	0.8	1.9	4.0	7.0
Women								
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
20/10 or better	0.8	1.8	1.1	1.3	0.4	-	-	-
20/15	24.9	42.0	43.2	36.2	12.3	3.3	0.7	-
20/20	24.8	26.9	31.0	36.5	26.7	14.2	2.2	1.6
20/30	15.2	11.3	11.6	12.8	24.2	17.0	16.1	8.5
20/40	6.2	4.4	2.7	3.3	7.2	12.0	11.1	10.3
20/50	4.6	2.4	1.4	1.9	6.9	7.3	9.4	13.4
20/70	3.8	1.0	1.4	1.4	4.3	7.8	6.8	21.2
20/100	11.2	4.4	2.0	2.8	11.1	25.1	33.3	26.1
20/200	5.3	3.6	2.3	2.3	4.7	11.1	11.4	9.8
Less than 20/200	3.2	2.2	3.3	1.5	2.2	2.2	9.0	9.1

Table 3. Number of adults reaching specified acuity levels for "corrected" distance vision, by age and sex: United States, 1960-62

Sex and acuity level	Total, 18-79 years	18-24 years	25-34 years	35-44 years	45-54 years	55-64 years	65-74 years	75-79 years
Both sexes	Number of adults in thousands							
Total	111,087	15,569	21,572	23,698	20,576	15,637	11,164	2,871
20/10 or better	1,635	373	553	414	194	76	25	-
20/15	42,638	8,999	12,472	12,483	6,403	1,747	487	47
20/20	36,505	4,277	6,314	8,421	8,001	6,022	3,084	386
20/30	19,774	1,588	1,605	1,677	4,222	5,233	4,344	1,105
20/40	5,004	215	319	342	869	1,334	1,407	518
20/50	1,971	64	57	180	313	402	687	268
20/70	969	-	89	78	105	246	225	226
20/100	1,702	7	106	49	332	391	590	227
20/200	423	29	42	21	75	114	104	38
Less than 20/200	466	17	15	33	62	72	211	56
Men								
Total	52,744	7,139	10,281	11,373	10,034	7,517	4,972	1,428
20/10 or better	1,001	209	411	225	144	12	-	-
20/15	22,442	4,373	6,525	6,627	3,734	913	223	47
20/20	16,355	1,815	2,564	3,516	3,676	2,947	1,613	224
20/30	8,355	611	554	664	1,806	2,440	1,737	543
20/40	2,254	116	125	162	317	659	593	282
20/50	905	15	25	61	193	174	290	147
20/70	394	-	11	62	32	104	140	45
20/100	764	-	42	12	87	211	293	119
20/200	165	-	24	21	45	18	57	-
Less than 20/200	109	-	-	23	-	39	26	21
Women								
Total	58,343	8,430	11,291	12,325	10,542	8,120	6,192	1,443
20/10 or better	634	164	142	189	50	64	25	-
20/15	20,196	4,626	5,947	5,856	2,669	834	264	-
20/20	20,150	2,462	3,750	4,905	4,325	3,075	1,471	162
20/30	11,419	977	1,051	1,013	2,416	2,793	2,607	562
20/40	2,750	99	194	180	552	675	814	236
20/50	1,066	49	32	119	120	228	397	121
20/70	575	-	78	16	73	142	85	181
20/100	938	7	64	37	245	180	297	108
20/200	258	29	18	-	30	96	47	38
Less than 20/200	357	17	15	10	62	33	185	35

Table 4. Percent distribution of adults reaching specified acuity levels for "corrected" distance vision, by age and sex: United States, 1960-62

Sex and acuity level	Total, 18-79 years	18-24 years	25-34 years	35-44 years	45-54 years	55-64 years	65-74 years	75-79 years
Both sexes	Percent distribution							
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
20/10 or better	1.5	2.4	2.6	1.7	0.9	0.5	0.2	-
20/15	38.4	57.8	57.7	52.8	31.1	11.2	4.4	1.6
20/20	32.9	27.5	29.3	35.5	39.0	38.4	27.6	13.4
20/30	17.7	10.2	7.4	7.1	20.5	33.5	38.9	38.6
20/40	4.5	1.4	1.5	1.4	4.2	8.5	12.6	18.0
20/50	1.8	0.4	0.3	0.8	1.5	2.6	6.2	9.3
20/70	0.9	-	0.4	0.3	0.5	1.6	2.0	7.9
20/100	1.5	0.0	0.5	0.2	1.6	2.5	5.3	7.9
20/200	0.4	0.2	0.2	0.1	0.4	0.7	0.9	1.3
Less than 20/200	0.4	0.1	0.1	0.1	0.3	0.5	1.9	2.0
Men								
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
20/10 or better	1.9	2.9	4.0	2.0	1.4	0.2	-	-
20/15	42.8	61.3	63.5	58.4	37.3	12.2	4.5	3.2
20/20	31.0	25.4	25.0	30.9	36.6	39.1	32.4	15.7
20/30	15.8	8.6	5.4	5.8	18.0	32.5	35.0	38.0
20/40	4.2	1.6	1.2	1.4	3.2	8.8	11.9	19.8
20/50	1.7	0.2	0.2	0.5	1.9	2.3	5.8	10.3
20/70	0.7	-	0.1	0.5	0.3	1.4	2.8	3.2
20/100	1.4	-	0.4	0.1	0.9	2.8	5.9	8.3
20/200	0.3	-	0.2	0.2	0.4	0.2	1.2	-
Less than 20/200	0.2	-	-	0.2	-	0.5	0.5	1.5
Women								
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
20/10 or better	1.1	1.9	1.3	1.5	0.5	0.8	0.4	-
20/15	34.7	54.9	52.6	47.5	25.3	10.3	4.3	-
20/20	34.6	29.2	33.2	39.8	41.1	37.8	23.8	11.2
20/30	19.5	11.6	9.3	8.2	22.9	34.4	42.1	39.1
20/40	4.7	1.2	1.7	1.5	5.2	8.3	13.1	16.4
20/50	1.8	0.6	0.3	1.0	1.1	2.8	6.4	8.4
20/70	1.0	-	0.7	0.1	0.7	1.8	1.4	12.5
20/100	1.6	0.1	0.6	0.3	2.3	2.2	4.8	7.4
20/200	0.4	0.3	0.2	-	0.3	1.2	0.7	2.6
Less than 20/200	0.6	0.2	0.1	0.1	0.6	0.4	3.0	2.4

Table 5. Number of adults reaching specified acuity levels for uncorrected near vision, by age and sex: United States, 1960-62

Sex and acuity level	Total, 18-79 years	18-24 years	25-34 years	35-44 years	45-54 years	55-64 years	65-74 years	75-79 years
Both sexes	Number of adult in thousands							
Total	111,087	15,569	21,572	23,698	20,576	15,637	11,164	2,871
14/7 or better	1,076	261	457	338	20	-	-	-
14/10.5	25,480	7,513	10,105	7,451	393	18	-	-
14/14	22,897	5,163	7,482	8,485	1,551	116	-	100
14/21	9,817	1,497	1,800	3,429	2,330	482	245	34
14/28	5,249	411	332	1,033	1,884	885	482	222
14/35	4,872	162	217	532	1,785	1,104	859	213
14/49	6,156	68	241	527	2,582	1,694	801	243
14/70	17,556	331	363	1,276	6,077	5,096	3,440	973
14/140	13,148	98	418	485	3,146	4,875	3,487	639
Less than 14/140	4,836	65	157	142	808	1,367	1,850	447
Men								
Total	52,744	7,139	10,281	11,373	10,034	7,517	4,972	1,428
14/7 or better	844	189	369	266	20	-	-	-
14/10.5	14,146	4,003	5,512	4,354	259	18	-	-
14/14	10,042	2,033	2,999	3,904	947	59	-	100
14/21	4,052	528	507	1,438	1,223	223	118	15
14/28	2,373	124	198	400	828	408	215	200
14/35	2,321	28	94	253	818	631	403	94
14/49	3,254	27	153	194	1,272	963	497	148
14/70	8,642	137	190	414	3,128	2,646	1,662	465
14/140	5,258	39	217	94	1,301	2,022	1,376	209
Less than 14/140	1,812	31	42	56	238	547	701	197
Women								
Total	58,343	8,430	11,291	12,325	10,542	8,120	6,192	1,443
14/7 or better	232	72	88	72	-	-	-	-
14/10.5	11,334	3,510	4,593	3,097	134	-	-	-
14/14	12,855	3,130	4,483	4,581	604	57	-	-
14/21	5,765	969	1,293	1,991	1,107	259	127	19
14/28	2,876	287	134	633	1,056	477	267	22
14/35	2,551	134	123	279	967	473	456	119
14/49	2,902	41	88	333	1,310	731	304	95
14/70	8,914	194	173	862	2,949	2,450	1,778	508
14/140	7,890	59	201	391	1,845	2,853	2,111	430
Less than 14/140	3,024	34	115	86	570	820	1,149	250

Table 6. Percent distribution of adults reaching specified acuity levels for uncorrected near vision, by age and sex: United States, 1960-62

Sex and acuity level	Total, 18-79 years	18-24 years	25-34 years	35-44 years	45-54 years	55-64 years	65-74 years	75-79 years
Both sexes	Percent distribution							
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
14/7 or better	1.0	1.7	2.1	1.4	0.1	-	-	-
14/10.5	23.0	48.4	46.9	31.4	1.9	0.1	-	-
14/14	20.7	33.2	34.8	35.9	7.5	0.7	-	3.5
14/21	8.9	9.6	8.3	14.5	11.3	3.1	2.2	1.2
14/28	4.7	2.6	1.5	4.4	9.2	5.7	4.3	7.7
14/35	4.4	1.0	1.0	2.2	8.7	7.1	7.7	7.4
14/49	5.5	0.4	1.1	2.2	12.5	10.8	7.2	8.5
14/70	15.7	2.1	1.7	5.4	29.6	32.6	30.8	33.8
14/140	11.8	0.6	1.9	2.0	15.3	31.2	31.2	22.3
Less than 14/140	4.3	0.4	0.7	0.6	3.9	8.7	16.6	15.6
Men								
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
14/7 or better	1.6	2.6	3.6	2.3	0.2	-	-	-
14/10.5	26.9	56.2	53.7	38.4	2.6	0.2	-	-
14/14	19.1	28.5	29.2	34.4	9.4	0.8	-	7.0
14/21	7.7	7.4	4.9	12.6	12.2	3.0	2.4	1.1
14/28	4.5	1.7	1.9	3.5	8.3	5.4	4.3	14.0
14/35	4.4	0.4	0.9	2.2	8.2	8.4	8.1	6.6
14/49	6.2	0.4	1.5	1.7	12.7	12.8	10.0	10.3
14/70	16.3	1.9	1.8	3.6	31.0	35.2	33.4	32.6
14/140	9.9	0.5	2.1	0.8	13.0	26.9	27.7	14.6
Less than 14/140	3.4	0.4	0.4	0.5	2.4	7.3	14.1	13.8
Women								
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
14/7 or better	0.4	0.8	0.8	0.6	-	-	-	-
14/10.5	19.6	41.7	40.7	25.1	1.3	-	-	-
14/14	22.1	37.1	39.7	37.1	5.7	0.7	-	-
14/21	9.9	11.5	11.4	16.2	10.5	3.2	2.0	1.3
14/28	4.9	3.4	1.2	5.1	10.0	5.9	4.3	1.5
14/35	4.4	1.6	1.1	2.3	9.2	5.8	7.4	8.3
14/49	5.0	0.5	0.8	2.7	12.4	9.1	4.9	6.6
14/70	15.2	2.3	1.5	7.0	28.0	30.2	28.7	35.2
14/140	13.4	0.7	1.8	3.2	17.5	35.0	34.1	29.8
Less than 14/140	5.1	0.4	1.0	0.7	5.4	10.1	18.6	17.3

Table 7. Number of adults reaching specified acuity levels for "corrected" near vision, by age and sex: United States, 1960-62

Sex and acuity level	Total, 18-79 years	18-24 years	25-34 years	35-44 years	45-54 years	55-64 years	65-74 years	75-79 years
Both sexes	Number of adults in thousands							
Total	111,087	15,569	21,572	23,698	20,576	15,637	11,164	2,871
14/7 or better	1,262	208	519	394	110	31	-	-
14/10.5	31,624	8,335	11,455	8,835	1,890	856	253	-
14/14	38,964	5,616	7,841	10,218	7,013	5,251	2,652	373
14/21	22,143	1,198	1,385	2,896	6,118	5,191	4,494	861
14/28	6,882	119	130	669	2,131	1,744	1,495	594
14/35	3,162	54	68	250	1,028	840	651	271
14/49	2,086	16	37	133	787	438	394	281
14/70	3,389	10	96	233	1,188	778	751	333
14/140	1,124	13	41	25	225	413	359	48
Less than 14/140	451	-	-	45	86	95	115	110
Men								
Total	52,744	7,139	10,281	11,373	10,034	7,517	4,972	1,428
14/7 or better	979	161	431	294	77	16	-	-
14/10.5	17,281	4,280	6,176	4,981	1,128	555	161	-
14/14	16,989	2,089	3,043	4,437	3,511	2,472	1,194	243
14/21	9,116	528	403	1,258	2,611	2,068	1,870	378
14/28	2,931	53	119	165	821	785	667	321
14/35	1,718	28	36	66	499	570	360	159
14/49	1,175	-	23	51	536	268	167	130
14/70	1,798	-	42	77	713	479	355	132
14/140	593	-	8	9	126	270	159	21
Less than 14/140	164	-	-	35	12	34	39	44
Women								
Total	58,343	8,430	11,291	12,325	10,542	8,120	6,192	1,443
14/7 or better	283	47	88	100	33	15	-	-
14/10.5	14,343	4,055	5,279	3,854	762	301	92	-
14/14	21,975	3,527	4,798	5,781	3,502	2,779	1,458	130
14/21	13,027	670	982	1,638	3,507	3,123	2,624	483
14/28	3,951	66	11	504	1,310	959	828	273
14/35	1,444	26	32	184	529	270	291	112
14/49	911	16	14	82	251	170	227	151
14/70	1,591	10	54	156	475	299	396	201
14/140	531	13	33	16	99	143	200	27
Less than 14/140	287	-	-	10	74	61	76	66

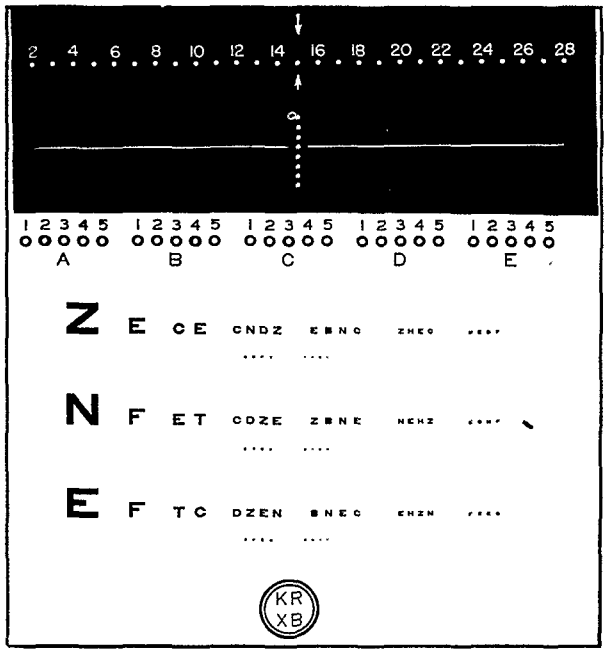
Table 8. Percent distribution of adults reaching specified acuity levels for "corrected" near vision, by age and sex: United States, 1960-62

Sex and acuity level	Total, 18-79 years	18-24 years	25-34 years	35-44 years	45-54 years	55-64 years	65-74 years	75-79 years
Both sexes	Percent distribution							
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
14/7 or better	1.1	1.3	2.4	1.7	0.5	0.2	-	-
14/10.5	28.6	53.4	53.1	37.3	9.2	5.5	2.3	-
14/14	35.2	36.2	36.4	43.0	34.1	33.5	23.8	13.0
14/21	19.8	7.7	6.4	12.2	29.7	33.2	40.3	30.0
14/28	6.2	0.8	0.6	2.8	10.4	11.2	13.4	20.7
14/35	2.8	0.3	0.3	1.1	5.0	5.4	5.8	9.4
14/49	1.9	0.1	0.2	0.6	3.8	2.8	3.5	9.8
14/70	3.0	0.1	0.4	1.0	5.8	5.0	6.7	11.6
14/140	1.0	0.1	0.2	0.1	1.1	2.6	3.2	1.7
Less than 14/140	0.4	-	-	0.2	0.4	0.6	1.0	3.8
Men								
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
14/7 or better	1.9	2.3	4.2	2.6	0.8	0.2	-	-
14/10.5	33.0	59.9	60.0	43.9	11.2	7.4	3.2	-
14/14	32.2	29.3	29.6	39.0	35.0	32.9	24.0	17.0
14/21	17.2	7.4	3.9	11.0	26.0	27.5	37.6	26.4
14/28	5.5	0.7	1.2	1.4	8.2	10.4	13.4	22.4
14/35	3.2	0.4	0.4	0.6	5.0	7.6	7.2	11.2
14/49	2.2	-	0.2	0.4	5.3	3.6	3.4	9.1
14/70	3.4	-	0.4	0.7	7.1	6.4	7.2	9.3
14/140	1.1	-	0.1	0.1	1.3	3.6	3.2	1.5
Less than 14/140	0.3	-	-	0.3	0.1	0.4	0.8	3.1
Women								
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
14/7 or better	0.5	0.6	0.8	0.8	0.3	0.2	-	-
14/10.5	24.7	48.0	46.7	31.3	7.2	3.7	1.5	-
14/14	37.8	41.9	42.5	46.8	33.3	34.2	23.5	9.0
14/21	22.2	7.9	8.7	13.3	33.3	38.4	42.4	33.5
14/28	6.7	0.8	0.1	4.1	12.4	11.8	13.4	18.9
14/35	2.5	0.3	0.3	1.5	5.0	3.3	4.7	7.8
14/49	1.5	0.2	0.1	0.7	2.4	2.1	3.7	10.4
14/70	2.7	0.1	0.5	1.3	4.5	3.7	6.4	13.9
14/140	0.9	0.2	0.3	0.1	0.9	1.8	3.2	1.9
Less than 14/140	0.5	-	-	0.1	0.7	0.8	1.2	4.6

APPENDIX I

TARGET SPECIFICATIONS AND ITEMS ON MEDICAL HISTORY RELATED TO VISION USED IN THIS REPORT

The three lines on the Sight-Screener target used for testing distance and near vision:



Specifications of letter sizes and numbers of letters on Sight-Screener targets for testing distance and near vision.

Visual angle in minutes subtended at standard test distance (20 ft. or 14 in.)[1]	Decimal equivalent of Snellen ratios (reciprocal of visual angle)	Snellen ratios for letter sizes used at		Number of letters at each level
		Distance (20 ft.)	Near (14 in.)	
10.00	.1000	20/200	14/140	1
5.00	.2000	20/100	14/70	1
3.50	.2859	20/70	14/49	2
2.50	.4000	20/50	14/35	4
2.00	.5000	20/40	14/28	4
1.50	.6667	20/30	14/21	4
1.00	1.0000	20/20	14/14	4
.75	1.3333	20/15	14/10.5	4
.50	2.0000	20/10	14/7	4

[1]This is the size of the visual angle of resolution in minutes of arc subtended by the width of the lines in the test letters used at each threshold level.

Selected Medical History Questions
(Excerpts from HES-204, Medical History—Self Administered)

46. a. Do you wear glasses? YES NO ?

If YES b. Do you wear them all the time? YES NO ?

If you don't wear them all the time, check below when you do wear them

c. For seeing at a distance

d. For reading

e. For watching TV

f. At other times When?_____

47. a. Do you have serious trouble with seeing, even when wearing glasses? YES NO ?

If YES b. Have you had this trouble in the past 12 months? YES NO ?

c. Have you ever seen a doctor about it? YES NO

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APPENDIX II

SOME TECHNICAL NOTES ON THE VISION TEST

The visual acuity test used in this survey is in effect a subjective examination of the form sense of the examinee or the ability which the eye possesses to perceive the shape or form of objects.

Experimental evidence has shown that, in addition to the distance from the target, the complexity of the form of the target letters, the effective illumination used, the target contrast between letters and background, and the end-point or scoring criteria will all affect the level obtained in such testing.[3, 11]

The range of 20 feet is the usual one selected for distance testing since rays of light from this distance are practically parallel. When in a state of rest, the eye is adapted for parallel rays coming from a distant object. To focus objects closer than 20 feet, as needed in near vision, the light rays from the object have to be bent so that they come together on the retina. The muscles of the eye accommodate for this by increasing the convexity of the lens and thus its refractive power.[6]

Binocular vision requires a further muscular adjustment not involved in monocular seeing. This is termed convergence or the directing of the visual lines from both eyes to a near point.[1]

Both the ability of the normal eye to converge and to accommodate will tend to decrease with age, but not necessarily at the same rate. Hence, some differences may be expected in the decrease of monocular and binocular acuity with age.

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APPENDIX III

SURVEY DESIGN, RESPONSE, AND SAMPLING VARIABILITY

The Survey Design

The Health Examination Survey is designed as a highly stratified multistage sampling of the civilian, noninstitutional population of the conterminous United States, aged 18-79 years. The first stage of the plan is a sample of the 42 primary sampling units (PSU's) from among some 1,900 such geographic units into which the United States was divided. A PSU is a standard metropolitan statistical area or one to three contiguous counties. Later stages result in the random selection of clusters of typically about four persons from a small neighborhood within the PSU. The total sample included approximately 7,700 persons in the 42 areas in 29 different States. The detailed structure of the design and the conduct of the Survey have been described in other reports.[1, 2]

Reliability in Probability Surveys

The Survey draws strength from the fact that the measurement processes which were employed were highly standardized and closely controlled. This does not mean, of course, that the correspondence between the real world and survey results is exact. Data from the survey are imperfect for three important reasons: (1) results are subject to sampling error; (2) the actual conduct of a survey never agrees perfectly with the design; and (3) the measurement process itself is inexact, even when standardized and controlled. The National Center for Health Statistics, both in special studies and in regular operations, tries to evaluate its surveys and to present the findings to consumers.

One part of this effort was reported which dealt largely with an analysis of the faithfulness with which the design was carried out. This study noted that of the 7,700 sample persons, the approximately 6,670 who were examined (a response rate of over 86 percent) give evidence that they are a highly representative sample of the civilian, noninstitutional population of the United States. Imputation for the nonrespondents was accomplished by attributing to nonexamined persons the characteristics of comparable examined persons. The specific procedure used has been described in another report.[2] It amounted to inflating the sampling weight for each examined person to compensate for sample persons at that stand and of the same age-sex group who were nonexamined.

In addition to persons not examined at all, there were some persons whose examination was incomplete in one particular or another. Age, sex, and race were known for every examined person, but for a number of persons one or more of the vision tests with or without glasses was not available. Most of the omissions were accidental. The extent of missing information for binocular tests is indicated in table I.

Table I. The extent of missing binocular vision data: Health Examination Survey, 1960-62

Type of test	Number of examinees
Total examinees	6,672
Distance and near tests without glasses completed	6,531
Only distance tests without glasses completed	3
Distance and near test done only with glasses	8
Only near tests with glasses completed	3
Not tested at distance or near with or without glasses	127

To estimate scores for the 14 individuals for whom at least one vision test was completed, a "regression-type" decision was made subjectively on the basis of the existing scores and test results for other persons of the same age, sex, and race.

For the 127 persons not given any of the vision tests, a probability selection was made of a respondent from the same age-sex-race group and his scores assigned to the nonrespondent.

Sampling and Measurement Error

In the present report and its appendices, several references have been made to efforts to evaluate both bias and variability of the measurement techniques.

The probability design of the survey makes possible the calculation of sampling errors. Traditionally, the role of the sampling error has been the determination of how imprecise the survey results may be because they come from a sample rather than from measurement of all elements in the universe.

The task of presenting sampling errors for a study of the type of the Health Examination Survey is difficult for at least three reasons: (1) measurement error and "pure" sampling error are confounded in the data; it is not easy to find a procedure which will either completely include both or treat one or the other separately, (2) the survey design and estimation procedure are complex and accordingly require computationally involved techniques for calculation of variances, (3) from the survey will come thousands of statistics, many for subclasses of the population for which there are small numbers of sample cases. Estimates of sampling error are obtained from the sample data and are themselves subject to sampling error, which may be large when the number of cases in a cell is small, or even occasionally when the number of cases is substantial. Estimates of approximate sampling variability for selected statistics used in this report are presented in table II. These estimates have been prepared by a replication technique, which yields overall variability through observation of variability among random subsamples of the total sample. The method reflects both "pure" sampling variance and a part of measurement variance.

In accordance with usual practice the interval estimate for any statistic may be considered to be the range within one standard error of the tabulated statistic, with 68 percent confidence; or the range with two standard errors of the tabulated statistic, with 95 percent confidence.

An overestimate of the standard error of a difference $d = x - y$ of two statistics x and y is given by the formula $s_d = [x^2V^2_x + y^2V^2_y]^{\frac{1}{2}}$, where V_x and V_y are the relative sampling errors, respectively of x and y. For example, tables 1 and 2 show $x = 17{,}792{,}000$ or 33.9 percent for men and $y = 14{,}494{,}000$ or 24.9 percent for women testing at distance without glasses at the 20/15 level. Table II shows relvariances relative sampling errors of $V_x = .04$ and $V_y = .04$ for the respective percentages. The formula yields the estimate of the standard error of the difference ($d = 9.0$ percent) as $s_d = 1.68$ percent. Thus the observed difference is more than five times its sampling error and hence significant.

A further example from table 2 shows $x = 109{,}000$ or 0.2 percent for men and $y = 357{,}000$ or 0.6 percent for women testing less than 20/200 with whatever correction they were using. Table II shows relative sampling errors of $V_x = 0.18$ and $V_y = 0.09$ for the respective percentages. The formula yields the estimate of the standard error of the difference ($d = 0.4$ percent as $s_d = 0.07$ percent. Here the observed difference is more than five times its sampling error and hence significant.

Small Categories

In some tables magnitudes are shown for cells for which sample size is so small that the sampling error may be several times as great as the statistic itself. Obviously in such instances the statistic has no meaning in itself except to indicate that the true quantity is small. Such numbers, if shown, have been included in the belief that they help to convey an impression of the overall story of the table.

Table II. Relative sampling error for proportion of persons with specified visual acuity,[1] by sex, race, and age: United States, 1960-62

Sex, race, and age	Visual acuity									
	20/10 or better	20/15	20/20	20/30	20/40	20/50	20/70	20/100	20/200	Less than 20/200
Both sexes	0.16	0.02	0.02	0.04	0.05	0.06	0.10	0.04	0.06	0.08
Male										
Total------	0.18	0.04	0.05	0.05	0.06	0.09	0.10	0.06	0.10	0.18
White--------	0.16	0.04	0.06	0.06	0.06	0.09	0.10	0.06	0.09	0.15
Negro--------	---	0.07	0.10	0.18	0.25	0.24	0.20	0.25	0.60	---
Age										
18-24 years--	0.30	0.05	0.10	0.08	0.18	0.60	0.50	0.30	0.40	---
35-44 years--	0.50	0.05	0.06	0.12	0.30	0.25	0.22	0.25	0.30	0.60
65-74 years--	---	0.70	0.15	0.12	0.16	0.22	0.28	0.15	0.22	0.15
Female										
Total------	0.18	0.04	0.02	0.06	0.05	0.06	0.16	0.05	0.05	0.09
White--------	0.18	0.04	0.03	0.06	0.06	0.06	0.18	0.06	0.06	0.10
Negro--------	---	0.12	0.05	0.06	0.15	0.20	0.22	0.25	0.30	0.20
Age										
25-34 years--	0.35	0.05	0.05	0.18	0.25	0.40	0.50	0.25	0.30	0.30
45-54 years--	---	0.07	0.08	0.09	0.13	0.14	0.15	0.10	0.10	0.24
75-79 years--	---	---	---	0.50	0.25	0.30	0.50	0.26	0.30	0.60

[1] Estimated relative sampling errors are shown in the table as computed for a considerable number of specific cells. It should be understood in any instance in which the estimated error for a particular cell differs markedly from those for other similar cells that the discrepancy may be a reflection of a real phenomenon, but might be the consequence of the fact that the estimated sampling error is itself subject to sampling variation.

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