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Association between Visual Field Defects and Quality of Life in the United States

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Abstract

Purpose—To investigate the association between visual field defects and quality of life in the United States population.

Design—Cross-sectional study

Participants—A total of 5,186participants in the 2005–2008 National Health and Nutrition Examination Survey (NHANES) aged 40 years and older without a self-reported history of age-related macular degeneration or prior refractive surgery who had undergone frequency doubling technology (FDT) perimetric testing.

Methods—FDT perimetry was performed in both eyes. Results from the better eye were used to categorize subjects as normal or having mild, moderate, or severe visual field loss. Subjects completed surveys about their visual and physical functioning ability.

Main outcome measures—Disability pertaining to six vision-related activities, two visual function questions, and five physical functioning domains.

Results—Eighty one percent of subjects had normal visual fields and 10%, 7% and 2% demonstrated mild, moderate and severe visual field defects, respectively. Subjects with greater severity of visual field defects had greater difficulty with vision-related activities. Subjects with severe visual field defects demonstrated the greatest odds of difficulty with all six activities. The two activities most adversely impacted were daytime driving in familiar places (Odds Ratio (OR): 12.4, 95% Confidence Interval (CI) 6.1–25.1) and noticing objects off to the side when walking (OR: 7.7, 95% CI: 4.7–12.7). Subjects with severe visual field defects had greater odds of worrying about eyesight (OR: 3.4, 95% CI 2.0–5.8) and being limited by vision in the time spent on daily activities (OR: 5.1, 95% CI 3.0–8.5). Subjects with severe visual field defects demonstrated the greatest odds of difficulty with three physical function domains including

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Subjects with worse visual field defects had high odds of disability with visual tasks as well as physical function domains, especially activities of daily living, instrumental activities of daily living, and leisure and social activities.

activities of daily living (OR: 2.45, 95% CI 1.37–4.38), instrumental activities of daily living (OR: 2.45, 95% CI: 1.37–4.38), as well as leisure and social activities (OR: 3.29, 95% CI: 1.87–5.77).

Conclusions—Greater severity of visual field abnormality was associated with significantly greater odds of disability with vision-related function and physical function. These findings support the necessity of routine screening to find those who may benefit from therapy to prevent progressive glaucomatous vision loss.

INTRODUCTION

Glaucoma, the leading cause of irreversible blindness worldwide,[1] can adversely impact patient quality of life, even in circumstances where those affected are unaware of the diagnosis.[2–4] Primary open-angle glaucoma (POAG) is the most prevalent form of glaucoma in the United States (US),[5] and it has been estimated that half of those with this condition may not be aware that they have the disease.[6,7] There is good evidence from adequately powered prospective randomized clinical trials that intraocular pressure (IOP) lowering therapy for adults with increased IOP detected on screening reduces the number of individuals who develop visual field defects, and such treatment of those with early asymptomatic POAG decreases the likelihood of visual field defect progression.[8,9]

Although the relationship between glaucoma and visual field defects has been well established, there has been insufficient evidence to determine the extent to which glaucoma screening, leading to earlier detection and treatment, reduces impairment in vision-related function or general quality of life. Therefore, the United States Preventative Services Task Force currently does not make any recommendations for or against glaucoma screening.[10] In recent years, there have been some studies suggesting a relationship between visual field defects and impaired quality of life,[3,4,11–17] but there have been no large cross-sectional epidemiologic studies of a representative sample of the entire US population investigating this possible association.

The National Health and Nutrition Examination Survey (NHANES)[18] is a population-based study conducted annually in the US which includes data pertaining to visual field status on frequency doubling technology (FDT) perimetry as well as self-reported vision-related disability and physical functional disability. While NHANES includes a questionnaire item for self-reported glaucoma, it does not include a complete ophthalmologic exam, and therefore does not provide a good assessment of glaucoma diagnosis. In an effort to bridge the knowledge gap regarding the relationship between glaucoma, progressive visual field defects, and the putative impact on quality of life, this study investigates the association between the presence and severity of visual field defects based upon results of FDT perimetry and the prevalence of vision-related and physical functional disability using data from NHANES.

METHODS

Sample and Population

We used data from the 2005 to 2008 NHANES, a cross-sectional series of interviews and examinations of the civilian, non-institutionalized US population administered by the Centers for Disease Prevention and Control (CDC). The purpose of NHANES is to provide information on US health statistics. The study makes de-identified data available to the public. NHANES uses a stratified multistage sampling design with a weighting scheme to accurately estimate disease prevalence in the US population. The NHANES protocol was approved by a human subjects review board at the CDC. Informed consent was obtained from all participants.[18]

Our analysis included all NHANES participants between the years 2005–2008 who: 1) were aged 40 years and older, 2) self-reported no history of refractive surgery or age-related macular degeneration, and 3) successfully underwent FDT perimetry examination.

Predictor Variable

The primary predictor variable was visual field status which was determined with a 19-point supra-threshold screening test using the N-30–5 algorithm of FDT perimetry.[19] Each subject underwent two FDT visual field tests per eye. Examinations were considered unreliable if either of the 2 tests on each eye had at least 2 out of 3 false-positive or fixation errors, or the technician supervising the test noted lack of fixation. We stratified results of the first visual field test administered for each eye into normal, mild, moderate, or severe visual field defects based on the clinical classification scheme previously published and validated against the Glaucoma Staging System, which showed a Cohen Kappa agreement of .679 and specificity of 95%.[20] The visual field result from each subject's better eye was used for the analysis. The classification of severe glaucoma was slightly modified for our study and defined as more than 9 P<1% defects (same as the original criteria), or more than 12 abnormal points with more than 6 P<1% defects (modified from the original criteria where the cutoff was 0.5% rather than our 1%). This slight modification was necessary due to lack of P<0.5% threshold data in the NHANES dataset.

In addition, to determine the extent to which subjects with visual field defects represent glaucoma patients, we examined the prevalence of self-reported glaucoma and vertical cup-to-disc-ratio ≥ 0.7 in each eye among subjects in each visual field group. Self-reported glaucoma was determined by the answer to the survey question: "Have you ever been told by an eye doctor that you have glaucoma, sometimes called high pressure in your eyes?" The vertical cup-to-disc ratio was graded from fundus photographs taken with a Canon Non-Mydriatic Retinal Camera CR6-45NM (Canon, Tokyo, Japan).

Confounding Variables

In the multivariable model, we adjusted for potential confounders with regard to the relationship between visual field defects and quality of life including age, gender, ethnicity, annual household income, education level, presenting visual acuity, and history of cataract surgery.

Outcome Variables

Vision-Related Functional Disability. The Vision Questionnaire asked participants about their eyesight and activity limitations due to their vision. The questions were selected from the National Eye Institute 25-item Visual Functioning Questionnaire, for which reliability and validity information has been previously reported.[21] http://archopht.jamanetwork.com/article.aspx?articleid=1660943 - ref-ecs120088-17 We included all of the questions asked by NHANES pertaining to vision-related function in our analysis. Six survey questions asked participants how much difficulty they have in performing the following activities: (V-Q1) reading ordinary newsprint; (V-Q2) doing work or hobbies that require seeing well up close; (V-Q3) going down steps, stairs, or curbs in dim light or at night; (V-Q4) noticing objects off to the side while walking; (V-Q5) finding objects on a crowded shelf; and (V-Q6) daytime driving in familiar places. A participant's answer to each of these questions was coded as "no difficulty, a little difficulty, moderate difficulty, extreme difficulty, or unable to do so because of eyesight." Subjects were excluded if they responded "does not do this for other reasons," "don't know," or refused to answer the question. Responses to these six questions were dichotomized into "no difficulty" versus "any difficulty." The survey also included two additional questions about a participant's subjective visual disability: (V-Q7) how much of the time do you worry about your eyesight?; and (V-Q8) how limited are you in how long you can work or do other daily activities such as housework, child care, school, or communication activities because of your vision? A participant's answer to these two questions was coded as "none of the time," "a little of the time," "some of the time," "most of the time," or "all of the time." Subjects were excluded if they responded "don't know" or refused to answer the question. Responses to these two questions were dichotomized into "none of the time" versus "any of the time."

Physical Functional Disability. The Physical Functioning Questionnaire consisted of 19 questions designed to survey the functional status of participants. These questions were phrased to assess the individual's level of difficulty in performing the task without using any special equipment. We included all of the questions asked by NHANES relating to physical function in our analysis. The questions were categorized into five major domains according to previously published definitions:[22] activities of daily living (ADL): eating, walking, dressing, getting out of bed; instrumental activities of daily living (IADL): managing money, housekeeping, food preparation); leisure and social activities (LSA): attending social events, going out to movies, in-home leisure activities; lower extremity mobility (LEM): walking for a quarter mile, walking up ten steps; and general physical activities (GPA): stooping, bending, standing, sitting, lifting, reaching, grasping. A participant's answer to a given question was coded as "no difficulty," "some difficulty," "much difficulty" or "unable to do". Subjects were excluded if they responded "don't know" or refused to answer the question. Responses to each of the 19 questions were dichotomized into "no difficulty" versus "any difficulty." Functional disability was defined as any difficulty in performing one or more activities within a given domain.

Data Analysis

We compared the distribution of demographic characteristics, possible confounding variables, vision questionnaire responses, and physical functioning questionnaire responses between the study population of 5,186 subjects who were able to successfully undergo FDT testing and the 795 subjects who were excluded because they were unable to undergo FDT testing using design-adjusted Rao-Scott Pearson-type χ^2 and Wald tests for categorical and continuous variables, respectively. Furthermore, amongst the study subjects, those within each visual field defect group were compared to each other using the same methodology.. Multivariable logistic regression models were created to examine the independent association between severity of visual field defect and each of the eight vision questionnaire questions and five physical function questionnaire domains, while adjusting for potential confounders. In an effort to accurately calculate confidence intervals around estimates for the US national population, we performed all data analyses (Stata 12.0; Stata Statistical Software, College Station, TX) using weighted data, calculating standard errors of population estimates using Taylor linearization methods.

RESULTS

The 2005–2008 NHANES data yielded 6,797 subjects aged 40 years and older. After excluding participants with a self-reported history of refractive surgery or age-related macular degeneration, 5,981 subjects remained. From this group, 5,186 participants successfully underwent FDT perimetry, whereas 795 subjects did not. Compared to subjects who successfully underwent FDT testing, those who did not were older (58.6 years vs. 56.34 years, P<0.01), less likely to be Caucasian (66.2% vs. 76.7%, P<0.01), less likely to have annual household income greater than $45,000 (48.8% vs. 58.9%, P<0.01), and less likely to have graduated from high school (69.3% vs. 82.2%, P<0.01). There was no difference in gender distribution between the two groups (P=0.08). Furthermore, those who did not successfully undergo FDT testing were less likely to have had a presenting visual acuity of 20/25 or better (74.1% vs. 83.6%, P<0.01), more likely to have self-reported prior cataract surgery (13.2% vs. 9.0%, P=0.01), and more likely to have self-reported a history of glaucoma (6.7% vs. 4.4%, P=0.03). There was no difference in the prevalence of vertical cup-to-disc-ratio ≥ 0.7 in the right eye (P=0.37) or left eye (P=0.88) between the two groups. The 5,186 subjects who were able to successfully undergo FDT testing comprise our study population.

Overall, 81% of subjects had normal visual fields and 10%, 7% and 2% had mild, moderate and severe visual field defects, respectively. Greater visual field defect severity was associated with older age, non-Caucasian race-ethnicity, lower annual income, lower education level, worse presenting visual acuity, and history of cataract surgery (all P-values <0.001). The prevalence of self-reported glaucoma increased with greater severity of visual field defects, ranging from 3% in those with normal visual fields to 24% in those with severe visual field defects (P<0.0001) (Table 1).

For each of the eight questions about vision-related function and for each of the five physical functioning domains, the prevalence of disability was higher in the groups with worse visual field defects (all P-values <0.0001) (Table 2).

Subjects with normal visual fields served as the reference group in the multivariable logistic regression models which adjusted for possible confounders. Subjects with greater severity of visual field loss had greater difficulty with vision-related tasks (Table 3). Those with mild visual field defects had greater odds of difficulty with two out of the six activities on the vision questionnaire compared to subjects with normal visual fields: doing work or hobbies that require seeing well up close (Odds Ratio (OR): 1.5, 95% Confidence Interval (CI): 1.1–2.1) and going down steps, stairs or curbs in dim light or at night (OR: 1.5, 95% CI: 1.2–2.0). The odds of difficulty with the other four activities were also greater but these differences were not statistically significant. Subjects with moderate visual field defects had greater odds of difficulty with all six activities on the vision questionnaire compared to subjects with normal visual fields. The two activities with the highest odds ratios were noticing objects off to the side when walking (OR: 2.7, 95% CI 1.9–3.9) followed by daytime driving in familiar places (OR: 2.4, 95% CI: 1.1–5.3). Subjects with severe visual field defects also demonstrated greater odds of difficulty with all six activities on the vision questionnaire compared to subjects with normal visual fields and these differences were greater than those found in subjects with moderate visual field loss. As was the case with moderate visual field loss, the two activities most impacted by severe field loss were daytime driving in familiar places (OR: 12.4, 95% CI 6.1–25.1) followed by noticing objects off to the side when walking (OR: 7.7, 95% CI: 4.7–12.7).

On the two additional questions about participants' subjective visual disability, subjects with moderate visual field defects had greater odds of worrying about eyesight (OR: 1.7, 95% CI 1.2–2.3) and being limited by vision in how long they can perform daily activities (OR: 1.7, 95% 1.1–2.5) compared to subjects with normal visual fields. Subjects with severe visual field defects had even greater odds of reporting impairment with regard to these two parameters with odds ratios of 3.4 (95% CI: 2.0–5.8) and 5.1 (95% CI: 3.0–8.5), respectively.

Subjects with greater severity of visual field loss also had more difficulty with physical functioning (Table 3). Subjects with mild visual field defects had modestly increased odds of difficulty with four out of the five physical function domains compared to subjects with normal visual fields, but these differences did not reach statistical significance. Subjects with moderate visual field defects had statistically significantly greater odds of difficulty with two physical function domains compared to subjects with normal visual fields: instrumental activities of daily living (OR: 1.71, 95% CI: 1.09–2.68) as well as leisure and

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social activities (OR: 1.87, 95% CI: 1.15–3.05). As was the case with other parameters, subjects with severe visual field defects demonstrated the greatest odds of difficulty with three physical function domains compared to subjects with normal visual fields: activities of daily living (OR: 2.45, 95% CI 1.37–4.38), instrumental activities of daily living (OR: 2.45, 95% CI: 1.37–4.38), as well as leisure and social activities (OR: 3.29, 95% CI: 1.87–5.77).

The 795 subjects who were unable to successfully undergo testing were more likely to have had vision-related as well as physical-functioning disability compared to the study population. Those unable to undergo FDT testing were more likely to have had disability with reading newsprint (30.0% vs.25.0%, P<0.01), steps and curbs in dim light (23.8% vs. 17.9%, P<0.01), seeing objects to the side (12.6% vs. 8.7%, P<0.01), finding objects on crowded shelves (14.3% vs. 11.0%, P=0.01), driving in familiar places (5.0% vs. 3.3%, P=0.01), and being limited by their vision in how long they can perform activities (18.0% vs. 10.0%, P<0.01). This excluded group of 795 individuals were more likely to have had disability with activities of daily living (17.4% vs. 12.8%, P<0.01), instrumental activities of daily living (20.0% vs. 14.6%, P<0.01), and leisure and social activities (15.8% vs. 10.9%, P<0.01) relative to the study population.

DISCUSSION

This study of a population-based sample of adults in the US aged 40 years and older found an association between visual field defect severity on FDT perimetry and disability with vision-related function and physical function. Vision-related activities that were the most difficult for subjects with visual field defects included driving a car in familiar places and noticing objects off to the side while walking. Of note, these particular activities rely upon peripheral vision, which may be affected in glaucoma patients early in the course of the disease. When asked about their visual function, subjects with severe visual field defects were three times as likely to worry about their vision and five times as likely to be limited by vision in the performance of daily activities compared to subjects with normal visual fields. There were several physical functioning domains that were especially difficult for subjects with visual field defects. Subjects with severe visual field defects were two to three times as likely to have difficulty with activities of daily living, instrumental activities of daily living, and leisure and social activities. Overall, greater severity of visual field defects was associated with more pronounced impairment in quality of life, and this association was stronger with vision-related disability than with physical functioning disability.

Our results from a large cross-sectional study of a representative sample of the U.S. population support those from previous smaller trials that have demonstrated the association between visual field defects and quality of life. Several studies have found associations between monocular or binocular visual field loss with worse subjective and objective measures of both vision-related, as well as general quality of life.[3,4,11–17] A previous study of glaucoma patients reported that the amount of binocular visual field loss and the status of the better eye most accurately predicted functional ability and quality of life as measured by an objective, performance-based measure of visual function, as well as a subjective, standardized measure of vision-related quality of life.[11] Additional work found visual acuity and visual field loss in patients with glaucoma and macular degeneration to be associated with self-reported difficulties with instrumental activities of daily living, specifically preparing meals, grocery shopping, and out-of-home traveling.[16] Monocular and binocular visual field loss severity, especially central field loss, even among subjects who were unaware that they had glaucoma, has been shown to be associated with worse vision-related quality of life but not general health related quality of life.[4] Nelson and colleagues reported that severity of binocular visual field loss was associated with perceived visual disability related to certain tasks, particularly involving dark adaptation and glare disability, activities

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demanding functional peripheral vision such us tripping over and bumping into objects and outdoor mobility tasks.[3] Other important work on the subject has shown that there is an association between visual field loss with worse vision-related and general quality of life and that faster rates of binocular visual field progression are associated with worse vision-related quality of life.[13, 15]

Our study found an association between severity of visual field defects and worse quality of life in both the areas of vision-related function and general physical function. Compared to prior work, our study, by using a large existing database representing the entire US population, had a much larger sample size but did not exclusively consist of those with confirmed glaucoma or suspicion of this disease. However, it is noteworthy that glaucoma is by far the most common cause of visual disability selectively causing greater peripheral than central vision loss in the early stages of disease. NHANES does not include a complete ophthalmic exam or longitudinal follow-up data, so we cannot be certain as to the glaucoma diagnosis status of each of our study subjects. To address this issue, we evaluated the prevalence of self-reported glaucoma and vertical cup-to-disc ratio ≥ 0.7 in each eye among subjects in each visual field group. As would have been expected, we found an increasing prevalence of self-reported glaucoma as well as vertical cup-to-disc ratio ≥ 0.7 in both the right and left eyes among those with greater visual field defects. It may be reasonable to assume that the prevalence of glaucoma is higher amongst the groups with greater severity of visual field defects. However, even in the severe visual field defect group, the prevalence of self-reported glaucoma and vertical cup-to-disc ratio ≥0.7 in each eye was only approximately 24% and 15% respectively. It is noteworthy that prior studies have shown that 50–75% of those with POAG in the United States may be unaware that they have the disease.[7,23] As NHANES does not include comprehensive ophthalmic examinations, it is not possible to draw accurate conclusions about the association between glaucoma and quality of life based only on our study results. We are limited to assessing the association between severity of visual field defects and quality of life, irrespective of glaucoma diagnosis.

Furthermore, our study used FDT perimetry to measure visual field defects whereas most other trials use standard automated perimetry. While FDT may be as good or better for accurate detection of early glaucomatous disease relative to standard automated perimetry, the latter test is the gold standard for determining disease severity and progression of existing field defects.[24] The prevalence of visual field loss that we found in our study may not be directly comparable to that found in other studies using standard automated perimetry. As previously mentioned, we used a visual field defect classification algorithm that was based on a clinical classification scheme previously published and validated against the Glaucoma Staging System, which had shown a Cohen Kappa agreement of .679 and specificity of 95%.[20] It is therefore reasonable to assume that our predictor variable reasonably categorizes subjects based on their severity of visual field loss. As with prior work by Spaeth et al which analyzed performance-based measures of visual function,[11] van Landingham et al recently reported an association between visual field loss and diminished accelerometer-defined walking and physical activity using data from the 2005–2006 NHANES.[25] Our study, in contrast, assessed self-reported visual and physical limitations with results supporting van Landingham et al's conclusions that there is an association between visual field loss and decreased quality of life." Additionally, the prior study found an association with visual acuity loss from macular degeneration and impaired quality of life,[16] whereas our study excluded subjects with self-reported macular degeneration and adjusted for visual acuity in our multivariable model.

In addition, it is noteworthy that our classification of severe visual field defects was slightly modified from that validated and published by Brusini et al.[20] By using a less strict P<1% threshold, the size of the group with severe visual field defects was larger than it would have been had the more strict P<0.5% criteria employed by Brusini et al been used. However, it is not possible to determine how many subjects were classified as having severe visual field defects that would not have been otherwise, since the NHANES did not have P<0.5% threshold data. Nonetheless, it would be reasonable to assume that the individuals in this smaller group would be the ones with the most severe visual field loss and correspondingly the most extensive vision-related and physical functioning disability. If the data was available allowing the use of these stricter criteria, then it is reasonable to assume that the odds ratio would likely have been even higher. Therefore, we have biased our results toward the null by using the less strict threshold, and despite this we still found significantly higher odds of vision-related as well as physical functioning disability in the group with severe visual field defects.

There is no generally accepted gold standard quality of life instrument to use in patients with glaucoma, and many scales are biased toward physical symptoms that do not address the personal or social factors of the disease.[12] Vision-related quality of life has often been measured using questionnaire-based, self-reported assessments, such as the 25-item National Eye Institute Visual Function Questionnaire (VEI VFQ-25).[21] Previous studies have reported an association between more severe or more rapidly progressing visual field defects on standard automated perimetry and worse scores on the NEI VFQ-25.[11–15] Visual field assessment of the better eye was more strongly associated with the questionnaire results than found with the worse eye, likely because the better eye may compensate for the visual field loss of the worse eye. For our study, the NHANES included a subset of standardized questions from the NEI VFQ-25 to measure vision-related quality of life, which served as our outcome variable.

General health-related quality of life has been measured with various validated surveys, and previous studies have reported conflicting results regarding whether or not visual field loss is associated with general quality of life.[3,4, 11–13, 16, 26, 27] Overall there appears to be a pattern toward stronger association between visual field defects and vision-related quality of life than general quality of life measures. We found an association between visual field defects and both vision-related as well as general quality of life parameters, with a stronger association noted with the former relative to the latter parameter.

Furthermore, there were subjects who met the study inclusion criteria but did not successfully undergo FDT testing and were therefore not included in our final study population. This group tended to be older and have a higher prevalence of self-reported glaucoma, history of cataract surgery, and worse presenting visual acuity, suggesting that this sub-population may have had worse ocular health which may have limited their ability to undergo FDT testing. When we further investigated the prevalence of vision-related and physical functioning disability in this group, these excluded individuals were also significantly more likely to have disability with all of the vision-related activities except for near work as well as the same three physical functioning domains (activities of daily living, instrumental activities of daily living, and leisure and social activities) that were difficult for the groups with greater severity of visual field defects. It is likely that an accurate assessment of these subjects' visual fields might have resulted in an even stronger association between visual field abnormalities and impairment with vision-related and physical functioning.

There are several additional potential limitations of our study that are worth noting. The cross-sectional design does not allow us to draw conclusions about the direction of causation or assess the hypothesis that glaucoma screening may reduce future vision related disability. Furthermore, there are many other ocular or neurological conditions that can cause visual field defects, and although we have excluded self-reported age-related macular degeneration from our analysis, we do not have a population of subjects who definitively have glaucoma. So while our results support a correlation between visual field defects and impaired quality of life, we do not provide conclusive evidence that increasing glaucoma screening would reduce the impairment in quality of life. Furthermore, glaucomatous damage commonly affects peripheral vision prior to central vision, and the former may not interfere with performance on some vision-related tasks that depend on normal central vision. There is also the possibility of residual confounding by visual acuity, since this parameter was treated as a categorical variable in our analysis. Presenting visual acuity was divided by NHANES into nine categories ranging from 20/20 to worse than 20/200. We subsequently collapsed several categories together to create three strata based upon the World Health Organization (WHO) criteria for low vision published by the American Optometric Association[28]: 20/20 to 20/25 was considered no vision loss, 20/30 to 20/50 was considered mild vision loss (WHO criteria is 20/30 to 20/60), and all other categories 20/60 and worse were collapsed together to be considered moderate visual impairment or worse. WHO has distinct criteria for moderate low vision, severe low vision, profound low vision, near total blindness, and total blindness. Due to the small sample size in the groups with worse visual acuity, we moved subjects with 20/60 visual acuity from the second group into the third group, thereby ensuring that there was a sufficiently large sample in each group. Glaucoma is also known to impair contrast sensitivity, which may specifically impact tasks such as reading newsprint, with less impact on other vision related activities. The lack of a statistically significant increase in disability with lower extremity mobility and general physical activity may be attributed to the nature of glaucomatous visual field damage that still allows for preserved function in these activities which may not rely as heavily on vision. Furthermore, our outcome measures were self-reported questionnaire items, which have been previously validated, but have the potential to be misunderstood by patients, especially if they are assessed with the aid of a language interpreter. Furthermore, it is not possible to mask patients with regard to their visual field status when they are answering questions pertaining to their visual and physical function and thus it is possible that subjects who knew that they have a chronic eye condition might have been more biased toward reporting difficulty with vision-related activities.

In summary, we found that after adjusting for confounding factors, greater severity of visual field defects was associated with significantly greater odds of disability with vision-related function and physical function specifically in the areas of instrumental activities of daily living, and leisure and social activities. Since there was evidence of an association between visual field abnormalities and visual and physical disability, and it is known that glaucoma screening followed by appropriate treatment can prevent or slow the progression of visual field defects, our findings may provide some added evidence to support routine glaucoma screening amongst individuals over the age of 40. Although we are unable to determine whether or not each study subject had a diagnosis of glaucoma, our results remain important as glaucoma screening, by definition, is performed on individuals who do not yet know whether or not they have the disease. By diagnosing, treating and slowing the progression of glaucoma, we may favorably alter the performance of routine activities that impact quality of life.

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Table 1

Characteristics of Study Subjects, by Visual Field Defect (VFD) Status

	No VFD	Mild VFD	Moderate VFD	Severe VFD	
	N (%)	**N (%)**	**N (%)**	**N (%)**	**Total**
Number of Subjects	4,185 (80.70)	506 (9.76)	378 (7.29)	117 (2.26)	5,186
	% (Standard Error)[a]	**% (Standard Error)[a]**	**% (Standard Error)[a]**	**% (Standard Error)[a]**	**P Value[b]**
Age, years	55.69 (0.44)	59.89 (0.68)	59.72 (0.86)	63.43 (1.35)	<0.0001
Female	51.01 (0.76)	62.81 (2.39)	47.01 (2.97)	55.52 (7.45)	0.0004
Ethnicity					<0.0001
Mexican American	5.19 (0.69)	6.38 (1.70)	8.22 (1.71)	8.86 (3.21)	
Other Hispanic	2.94 (0.57)	4.97 (1.48)	4.49 (1.16)	4.22 (1.46)	
Non-Hispanic White	78.60 (1.95)	69.43 (3.87)	61.44 (4.84)	56.57 (6.92)	
Non-Hispanic Black	8.82 (1.19)	12.85 (1.82)	19.87 (2.85)	29.48 (5.39)	
Other and Multiracial	4.45 (0.54)	6.37 (2.10)	5.99 (2.27)	0.86 (0.86)	
Annual Household Income					<0.0001
<$20,000	12.88 (0.91)	18.00 (2.29)	22.15 (2.85)	39.31 (5.75)	
$20,000–$44,999	26.32 (1.30)	32.24 (3.31)	32.49 (3.82)	22.18 (4.70)	
$45,000–$74,999	23.53 (0.96)	17.42 (2.00)	17.45 (3.10)	20.88 (5.19)	
≥$75,000	35.07 (2.02)	29.74 (2.98)	24.94 (4.25)	10.75 (5.34)	
≥$20,000[c]	2.20 (0.37)	2.59 (0.81)	2.96 (1.11)	6.88 (3.65)	
Education					0.0002
< 9th grade	5.79 (0.67)	11.16 (1.46)	12.33 (2.15)	16.52 (3.46)	
9th – 11th grade	10.90 (0.86)	11.29 (1.55)	12.95 (2.38)	19.97 (5.58)	
HS[d] graduate / GED equivalent[e]	26.81 (1.06)	28.34 (2.35)	27.22 (3.02)	27.73 (4.34)	
Some college	29.18 (1.17)	24.09 (2.15)	23.47 (3.07)	12.82 (4.74)	
College graduate and beyond	27.31 (1.78)	25.13 (2.81)	24.03 (3.93)	22.96 (4.61)	
Visual Acuity					<0.0001
20/20 to 20/25	86.03 (0.72)	74.48 (2.61)	66.89 (3.12)	46.38 (5.82)	
20/30 to 20/50	13.18 (0.73)	22.65 (2.50)	29.53 (3.05)	43.47 (6.38)	
20/60 to 20/200+	0.79 (0.13)	2.87 (0.80)	3.58 (0.80)	10.15 (3.55)	
History of Cataract Surgery	7.69 (0.61)	12.36 (2.50)	18.50 (1.94)	34.61 (6.28)	<0.0001

	No VFD	Mild VFD	Moderate VFD	Severe VFD	
Self-Reported Glaucoma	3.43 (0.39)	6.25 (1.08)	13.49 (2.11)	23.89 (4.42)	<0.0001
Cup-to-Disc Ratio ≥ 0.7, Right Eye	0.36 (0.00)	1.82 (0.76)	3.14 (1.09)	15.59 (4.45)	<0.0001
Cup-to-Disc Ratio ≥ 0.7, Left Eye	0.39 (0.10)	1.83 (0.61)	3.76 (1.03)	15.05 (4.37)	<0.0001

[a] All means, proportions, and standard errors are weighted estimates of the United States population characteristics, taking into account the National Health and Nutrition Examination Survey's (NHANES) complex sampling design.

[b] All P-values are unadjusted. P values were calculated using Wald test for continuous variables and design-adjusted Rao-Scott Pearson chi squared test for categorical variables.

[c] Participants who were unable to provide a more specific annual household income were asked to indicate whether the household income exceeded $20 000 per year.

[d] HS: High School

[e] GED: General Education Diploma

Table 2

Prevalence of Impairment with Vision-Related and Physical Function for Subjects in Each Visual Field Defect (VFD) Category

VISION QUESTIONNAIRE	No VFD % (Standard Error)[a]	Mild VFD % (Standard Error)[a]	Moderate VFD % (Standard Error)[a]	Severe VFD % (Standard Error)[a]	P-Value[b]
Difficulty with:[c]					
Reading ordinary newsprint	23.95 (1.07)	28.2 (3.48)	30.75 (2.52)	51.64 (5.91)	<0.001
Doing work/ hobbies requiring seeing up close	23.06 (1.08)	29.28 (3.03)	29.46 (2.61)	45.61 (6.03)	<0.001
Going down steps/curb in dim light or at night	15.94 (0.62)	25.51 (2.23)	29.03 (3.60)	60.96 (5.55)	<0.0001
Noticing objects off to the side when walking	7.16 (0.42)	10.73 (1.72)	21.22 (2.30)	45.28 (5.01)	<0.0001
Finding objects on a crowded shelf	9.55 (0.62)	12.73 (1.87)	23.44 (3.57)	44.68 (5.32)	<0.0001
Daytime driving in familiar places	2.55 (0.25)	5.20 (1.25)	8.33 (2.27)	28.25 (5.81)	<0.0001
Worried about eyesight[d]	44.87 (1.00)	47.38 (2.13)	56.87 (3.68)	70.18 (4.84)	<0.001
Vision limits how long you can do daily activities[d]	8.70 (0.65)	13.59 (2.04)	17.01 (2.36)	41.57 (5.98)	<0.0001
PHYSICAL FUNCTIONING QUESTIONNAIRE					
Difficulty with:[c]					
Activities of daily living[d]	11.41 (0.62)	17.53 (2.49)	21.11 (2.58)	38.08 (6.70)	<0.0001
Instrumental activities of daily living[e]	13.01 (0.65)	19.51 (2.45)	26.57 (3.55)	40.67 (7.88)	<0.0001
Lower extremity mobility[f]	11.47 (0.77)	17.36 (2.58)	16.92 (2.22)	20.34 (4.69)	<0.01
General physical activities[g]	31.43 (1.46)	40.93 (2.96)	48.26 (3.78)	56.56 (5.48)	<0.0001
Leisure and social activities[h]	9.45 (0.520	14.86 (2.12)	22.47 (2.80)	38.1 (6.54)	<0.0001

[a]All proportions and standard errors are weighted estimates of the United States population characteristics, taking into account the National Health and Nutrition Examination Survey's complex sampling design.

[b]All P-values are unadjusted and were calculated using design-adjusted Rao-Scott Pearson chi squared test.

[c]Responses to these questions were dichotomized into "no difficulty" versus "any difficulty." The percent reported is the proportion of the subjects who reported "any difficulty."

[d]Activities of daily living: eating, walking, dressing, getting out of bed.

[e]Instrumental activities of daily living: managing money, housekeeping, food preparation.

[f]Lower extremity mobility: walking for a quarter mile, walking up ten steps.

[g]General physical activities: stooping, bending, standing, sitting, lifting, reaching, grasping.

[h] Leisure and social activities: attending social events, going out to movies, in-home leisure activities.

Table 3

Odds of Impairment with Vision-Related and Physical Function in Subjects with Mild, Moderate, and Severe Visual Field Defects (VFD) Compared to Subjects with Normal Visual Fields[a]

VISION QUESTIONNAIRE	No VFD OR (95% CI)[a]	Mild VFD OR (95% CI)[a]	Moderate VFD OR (95% CI)[a]	Severe VFD OR (95% CI)[a]
Difficulty with:[b]				
Reading ordinary newsprint	1.00 (reference)	1.25 (0.83–1.88)	1.36 (1.06–1.76)	3.53 (1.98–6.29)
Doing work or hobbies that require seeing well up close	1.00 (reference)	1.49 (1.08–2.07)	1.53 (1.13–2.07)	3.44 (2.00–5.91)
Going down steps, stairs, or curb in dim light or at night	1.00 (reference)	1.54 (1.21–1.95)	1.80 (1.23–2.65)	6.56 (4.24–10.17)
Noticing objects off to the side when walking	1.00 (reference)	1.37 (0.94–1.99)	2.69 (1.85–3.91)	7.71 (4.70–12.67)
Finding objects on a crowded shelf	1.00 (reference)	1.13 (0.76–1.68)	2.22 (1.46–3.39)	5.54 (3.26–9.39)
Daytime driving in familiar places	1.00 (reference)	1.68 (0.92–3.05)	2.39 (1.09–5.26)	12.40 (6.12–25.14)
Worried about eyesight[c]	1.00 (reference)	1.17 (0.97–1.42)	1.69 (1.23–2.34)	3.44 (2.03–5.82)
Vision limits how long you can do daily activities[c]	1.00 (reference)	1.40 (0.96–2.03)	1.66 (1.10–2.53)	5.06 (3.02–8.47)
PHYSICAL FUNCTIONING QUESTIONNAIRE				
Difficulty with:[b]				
Activities of Daily Living[d]	1.00 (reference)	1.16 (0.75–1.81)	1.31 (0.82–2.08)	2.45 (1.37–4.38)
Instrumental Activities of Daily Living[e]	1.00 (reference)	1.29 (0.98–1.71)	1.71 (1.09–2.68)	2.50 (1.29–4.82)
Lower Extremity Mobility[f]	1.00 (reference)	1.20 (0.79–1.80)	1.01 (0.65–1.55)	1.06 (0.49–2.27)
General Physical Activities[g]	1.00 (reference)	0.99 (0.71–1.36)	1.38 (0.91–2.12)	1.32 (0.91–2.12)
Leisure and Social Activities[h]	1.00 (reference)	1.29 (0.86–1.90)	1.87 (1.15–3.05)	3.29 (1.87–5.77)

[a] Odds ratios (OR) and 95% confidence intervals (CI) from a multivariable logistic regression adjusting for age, gender, ethnicity, annual household income, education level, presenting visual acuity, and history of cataract surgery.

[b] Responses to these questions were dichotomized into "no difficulty" versus "any difficulty." The OR reported is for the outcome of "any difficulty."

[c] Responses to these questions were dichotomized into "none of the time" versus "any of the time." The OR reported is for the outcome of "any of the time."

[d] Activities of daily living: eating, walking, dressing, getting out of bed.

[e] Instrumental activities of daily living: managing money, housekeeping, food preparation.

[f] Lower extremity mobility: walking for a quarter mile, walking up ten steps.

[g] General physical activities: stooping, bending, standing, sitting, lifting, reaching, grasping.

[h] Leisure and social activities: attending social events, going out to movies, in-home leisure activities.