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Contrasting the Use of Two Vision-Specific Quality of Life Questionnaires in Subjects with Open-Angle Glaucoma

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Abstract

Purpose—To compare two vision-specific functional status measures to each other and to clinical parameters in the Collaborative Initial Glaucoma Treatment Study (CIGTS).

Methods—CIGTS participants completed the Visual Activities Questionnaire (VAQ) and the National Eye Institute-Visual Function Questionnaire (NEI-VFQ) and were tested for visual field (VF) and visual acuity (VA). 426 subjects contributed VAQ and NEI-VFQ scores at 54 months. Pearson correlations were used to assess associations.

Results—The VAQ subscales (range 0–100) that assessed light-dark adaptation (mean=66.1), glare disability (66.4), and acuity/spatial vision (67.7) indicated vision-related functions that CIGTS participants found most difficult. On the NEI-VFQ, subjects reported high levels of visual functioning, with mean ≥ 90 (out of 100) on the total score and in 9 of 12 subscales. General vision (mean=82.6) received the lowest subscale score. Two subscales common to both questionnaires were highly correlated: VA ($r=0.68$) and peripheral vision ($r=0.77$) (both $p<.0001$). Correlations between participants' perceptions and clinical measures of visual function were in the expected direction, but weaker. Stronger associations were found between clinical measures and the NEI-VFQ than the VAQ. Better eye VF and worse eye VA had the highest number of significant correlations with subjects' perceptions of their visual function. Increasing VF loss was associated with a significant decrease in the overall and peripheral vision subscale scores from both questionnaires, as well as several other subscales.

Conclusions—These findings will help researchers interested in assessing patients' perceptions of their visual function make an informed selection when choosing between the VAQ and the NEI-VFQ.

Keywords

Glaucoma; quality of life; visual field; visual acuity

Introduction

Patients' self-reported symptom experience, functional status, and quality of life (QOL) are increasingly important outcomes in clinical research across a broad spectrum of diseases and conditions. The advantage of a condition-specific measure is that it is clinically relevant, intuitively appealing to researchers and patients alike, more sensitive to the effects of disease and/or treatment course, and narrower in scope.

In the Collaborative Initial Glaucoma Treatment Study (CIGTS), two questionnaires were used to measure the impact of glaucoma and its treatment on the participants' functional status. The Visual Activities Questionnaire (VAQ)¹ was developed to assess the impact of treatment on activities of daily living involving vision.²⁻⁴ The National Eye Institute Visual Function Questionnaire (NEI-VFQ)^{5,6} was developed after the VAQ, and was tested for reliability and validity in participants who had cataract, macular degeneration, diabetic retinopathy, primary open-angle glaucoma, cytomegalovirus retinitis, or low vision from any cause. Since its development, it has been applied to patients with these and a number of other ophthalmic conditions in both clinical trials and population-based studies.⁷⁻¹²

Despite a literature establishing the psychometric properties and utility of the two measures individually, a direct comparison of the VAQ and the NEI-VFQ has not been reported. The Collaborative Initial Glaucoma Treatment Study (CIGTS) dataset provides a unique resource to compare and contrast these two measures in a sample of glaucoma patients.

The present manuscript seeks to extend the literature on the psychometric properties of these two measures by: (1) comparing the individual items, subscales, and performance of these two measures in the CIGTS sample; and (2) describing their relationship to two common clinical measures, visual field (VF) and visual acuity (VA).

Methods

Enrollment of CIGTS participants took place during a 3.5 year period from 1993 to 1997. 607 subjects who were newly-diagnosed with open-angle glaucoma at ages between 25 and 75 years were randomized to receive either medical therapy or trabeculectomy as their initial treatment. Subjects were recruited from 14 participating clinical centers across the U.S. After treatment initiation, subjects returned for standardized, comprehensive follow-up visits at 3- and 6-months and every 6 months thereafter. In addition, centralized telephone-administered QOL interviews were conducted at baseline, 2- and 6-months after treatment started, and every 6 months thereafter. Further details of the study protocol, eligibility criteria, and recruitment procedures are described elsewhere.¹³

The CIGTS followed the tenets of the Declaration of Helsinki and informed consent was obtained from participants after explanation of the nature and possible consequences of the study. The research was approved by the institutional review boards at the University of Michigan and all clinical centers.

Quality of Life and Clinical Measures

The QOL interview included a combination of generic and condition-specific measures.² When the trial began, the 33-item VAQ was chosen because it was deemed to be the most relevant glaucoma-specific measure of functional status available at the time. Five years later, the National Eye Institute developed and released its own measures of functional status, the 51-item Visual Function Questionnaire (NEI-VFQ)⁵ and then a reduced 25-item version.⁶ Both the VAQ and the NEI-VFQ assess patients' perceptions of their visual functioning and the impact of vision problems on their daily activities.

The VAQ contains 33 questions that measure the extent of difficulty individuals have performing everyday tasks that involve aspects of their visual function. Each item describes a particular vision problem and respondents are asked how often they experience this problem on a 5-point scale from 1 (never) to 5 (always). The VAQ yields a total score and eight subscale scores: color discrimination, glare disability, light-dark adaptation, acuity/spatial vision, depth perception, peripheral vision, visual search, and visual processing speed. All of the scores are calculated as means of the included items. Higher scores indicate worse visual functioning. The VAQ was administered at every interviewing time-point.

The NEI-VFQ is scored as an average of the included items transformed to a 0 to 100 scale where 0 represents the worst possible score and 100 represents the best. Responses to the NEI-VFQ can be summarized by a composite total score that is an un-weighted average of 11 of the 12 subscales (all except the single item General Health subscale). In addition, twelve subscale scores can be computed: general health, general vision, near vision, distance vision, driving, peripheral vision, color vision, and ocular pain as well as vision-specific role limitations, dependency, social function, and mental health. The NEI-VFQ was added to the CIGTS interview protocol once it became available, beginning with the 54-month interview, and administered annually thereafter. CIGTS subjects were encouraged to answer the NEI-VFQ but were allowed to decline participation.

Clinical measures in the CIGTS presented here included the mean deviation (MD) from Humphrey 24-2 full threshold VF testing, and best-corrected VA measured using Early Treatment Diabetic Retinopathy Study (ETDRS) letter charts¹⁴ and the examination protocol that was used in the Advanced Glaucoma Intervention Study.¹⁵ These clinical measures were obtained from examinations that took place at baseline (before treatment initiation) and every six months thereafter.

Data Analysis

Descriptive statistics included means, standard deviations (SD), and percentages. Linear relationships between the two QOL measures and their subscales were assessed using Pearson correlation coefficients. Clinical and QOL relationships were evaluated by correlation and analysis of variance testing. To provide for ease of interpretation, the 1 to 5 ("Never" to "Always" experiencing trouble/problems) scores used in the VAQ were transformed to correspond to directionality and scaling of the NEI-VFQ scores by the following conversion: 1=100, 2=75, 3=50, 4=25, & 5=0. SAS 9.1 statistical software (SAS Institute, Cary, NC) was used for all data analyses.

Results

Of the 607 subjects randomized into the CIGTS, 426 completed both the VAQ and NEI-VFQ questionnaires at the 54-month follow-up visit. Completion rates for the three main outcomes were: VAQ (n=510), NEI-VFQ (n=426) and clinical measures (n=480). Table 1 provides sociodemographic characteristics and clinical status indicators at baseline for three CIGTS groups: (1) all CIGTS participants (n=607); (2) the subjects of interest in this manuscript, those participants who completed the NEI-VFQ and VAQ at 54-months and provided clinical data (n=426); and (3) the non-responders who did not provide complete data at the 54-month follow-up period (n=181). CIGTS participants who did not provide complete data at 54-months differed significantly from responders in terms of race, education, income, employment, marital status and clinical severity. Specifically, non-responders at 54-months were significantly more likely to be black or other race, unmarried, and employed less than full-time. Also, a significantly greater percentage of non-responders had formal education less than high school and household incomes < \$20,000. Finally, non-responders had slightly lower VA at baseline than responders.

For those CIGTS participants who did provide complete data at 54-months, their average age at study entry was 57.8 years, 54% were male and 36% were African-American. More than 50% of the participants were employed either full- or part-time, while almost 30% were retired. 52% had at least some college experience, and 22% had less than a high school education. Table 1 summarizes the 54 month responders' baseline MD from VF testing (mean = -5.25 dB) and baseline VA (mean = 86.1 letters, equivalent to 20/20).

Appendix 1 offers a comparison of the VAQ and NEI-VFQ in terms of their respective subscales and individual items. The VAQ and NEI-VFQ both offer subscales assessing color vision, visual acuity/near vision, and peripheral vision. The two measures differ in some emphases. The VAQ adds five other visual function subscales related to glare disability, light-dark adaptation, depth perception, visual search, and visual processing speed. The NEI-VFQ adopts a structure similar to the generic SF-36 Health Survey¹⁶ with a focus on role limitations due to vision problems, notably social functioning, mental health, role difficulties, and dependency. The NEI-VFQ specifically includes a two-item subscale related to driving difficulties; the VAQ, instead, spreads seven driving-related items across four subscales (glare disability, peripheral vision, visual processing speed, and visual search). The two questionnaires also differ in terms of breadth and depth of item coverage in their shared subscales. For example, the VAQ employs five items to measure peripheral vision while the NEI-VFQ uses one.

Table 2 provides descriptive statistics on the VAQ and NEI-VFQ and their respective subscales. As shown, most of the mean VAQ scores are 75 or more, corresponding to "rarely" on the VAQ scale. After 54 months of follow-up, CIGTS participants reported, on average, having minimal problems with color discrimination (mean = 87.1) or depth perception (mean = 85.9). The visual function domains most affected on the VAQ were light-dark adaptation (mean = 66.1), glare disability (66.4), and acuity/spatial vision (67.7). Peripheral vision, considered one of the visual function indicators for glaucoma and its progression, was not a frequently reported problem in these subjects with glaucoma (mean = 81.5).

The NEI-VFQ results at 54-months showed mostly excellent visual function, with mean scores equal to or greater than 90 on the total score and 9 of the 12 subscales. Only the driving (mean = 88.6), general vision (82.6), and general health (68.3) subscales were lower than this threshold.

A correlation matrix comparing NEI-VFQ and VAQ scores is shown in Table 3. All of the correlations were statistically significant at the $p < .0001$ level. Significant correlations between the subscales ranged from 0.21 to 0.77. Some of the highest correlations were observed for the two measures' total scores ($r = 0.70$) and two subscales that are similar in content: (a) near activities on the NEI-VFQ and acuity/spatial vision on the VAQ ($r = 0.68$), and (b) both questionnaires' peripheral vision subscale ($r = 0.77$). Four of the NEI-VFQ measures (total score, near activities, distance activities, and peripheral vision) reached correlations of at least 0.50 with 7 of the 9 available VAQ measures. The VAQ subscales did not show the same consistent pattern of relationships with the NEI-VFQ scores; the VAQ total score and four VAQ subscales yielded correlations of 0.50 or greater with only 5 of the possible 13 NEI-VFQ scores. The four vision-specific functional elements of the NEI-VFQ (role difficulties, dependency, social functioning, and mental health) never achieved significant correlations greater than 0.50 with any of the VAQ scores. In addition, there were several subscales that seemed to tap unique elements of vision function with little shared relationship to other aspects. Notably, the two measures of subjects' perception of color vision were only weakly correlated with any other measure of visual function. These two

subscales (VAQ color discrimination and NEI-VFQ color vision) also were weakly correlated with each other ($r=0.33$).

Similar correlations were computed for the comparison of the two vision-specific functional status measures to available clinical measures of VF and VA; these results are shown in Table 4. In every case, correlations between the CIGTS subjects' perceptions and clinical measures were in the appropriate direction but weaker than those reported in Table 3. In general, stronger associations were found between the clinical measures and the NEI-VFQ than with the VAQ. The NEI-VFQ general vision subscale was significantly correlated with all five clinical measures (r -values >0.30). None of the VAQ subscales achieved a correlation of this magnitude with any of the clinical measures. The two clinical measures that had the highest number of significant correlations with participants' perceptions of their visual function were better eye MD (e.g., $r=0.37$ for the correlation with NEI-VFQ total score) and worse eye VA.

Both the NEI-VFQ composite score and the VAQ total score showed significant associations with worsening VF status (Table 5). Likewise, the peripheral vision subscales on both questionnaires reflected increasing functional difficulty with increasing VF loss ($p<0.0001$). Other subscales that related well to increasing VF loss included general vision, near activities, distance activities, and mental health in the NEI-VFQ, and color discrimination, depth perception, visual search, and visual processing speed in the VAQ. Of note is the discrepancy between associations of VF loss with color vision subscale findings, which were highly significant ($p<0.0001$) in the VAQ and not significant ($p=0.12$) in the NEI-VFQ.

Discussion

Results of the analyses showed reasonably good correlations between the two visual function questionnaires. While both color vision subscales failed to correlate significantly with any other measure, the VAQ and NEI-VFQ offered evidence of a number of related visual function indicators. Four of the NEI-VFQ scores (total, near activities, distance activities, and peripheral vision) were significantly correlated with at least seven of the nine available VAQ scores. Similarly, five of the VAQ scores (total, depth perception, peripheral vision, visual search, and visual processing speed) were significant correlated with five of the NEI-VFQ scores.

The two questionnaires contributed both unique and shared information on specific aspects of vision functioning that were affected in these 426 subjects with glaucoma. The VAQ revealed difficulties with glare and light-dark adaptation, which are functional problems that are not measured in the NEI-VFQ. Dark adaptation and glare were also noted as difficulties encountered by glaucoma patients in Nelson et al's study of glaucoma patients, who completed the Glaucoma Quality of Life – 15 questionnaire.¹⁷ Conversely, the NEI-VFQ measured an impact of general health, and more modest effects on driving, social functioning, and mental health, which are unique and not measured in the VAQ. Both instruments assess aspects of vision (acuity/general, color, peripheral). A study that used the NEI-VFQ to assess glaucoma subjects showed the most impact on general health and general vision,¹⁸ which is consistent with our NEI-VFQ findings.

In terms of associations with clinical benchmarks, the NEI-VFQ had a larger number of and stronger correlations with the five clinical measures than did the VAQ. In general, correlations between patients' perceptions and clinical parameters were lower than between the two psychosocial measures themselves. While statistically significant, none of these correlations exceeded 0.40, suggesting that clinical measures of visual function and a

subject's perception of visual function are related but distinct. From these data, it appears that the clinical parameters most strongly associated with patients' perception of their vision are better eye MD and worse eye VA. Jampel et al.¹⁹ also found that the worse eye VA was more strongly correlated with the composite NEI-VFQ score than the better eye VA (r-values of 0.32 and 0.18, respectively), and better eye MD was more strongly correlated with the NEI-VFQ composite score than the worse eye MD (r-values of 0.32 and 0.21, respectively). Reasons underlying why the worse eye VA and better eye MD relate more closely to patients' reports of their visual functioning are deserving of psychophysical investigation. Distant VA measurement is quite a different test than VF measurement, and brings out aspects of inter-eye performance that differ from VF testing in reported functioning at the person level.

When VF loss was categorized into minimal, mild, and moderate to severe levels, increasing VF loss was significantly associated with worsening overall scores from the two questionnaires, as well as the peripheral vision subscale of each instrument. Other subscales were also significantly responsive to increasing VF loss – the general vision, near activities, and mental health subscales of the NEI-VFQ, and the color discrimination, depth perception, visual search, and visual processing speed subscales of the VAQ. In general, our NEI-VFQ findings are very consistent with that reported by Ringsdorf et al. in a primarily African American group of glaucoma subjects,¹⁸ and our VAQ findings are unique given the lack of a literature on use of the VAQ in glaucoma.

The CIGTS dataset provides a unique opportunity to compare and contrast two available measures of patients' perceived visual function – the VAQ and the NEI-VFQ. The two measures share a number of features. They are both vision-specific, relatively brief, easy to administer, and offer total score and relevant subscale scores. Their differences, notably their structure and item coverage, form the basis by which researchers and clinicians might choose one measure over the other. The VAQ employs a response set designed to measure how *often* a respondent has problems with 33 specific visual function activities. The eight VAQ subscales that address particular aspects of visual function are made up of three to six items apiece; there may be, consequently, a greater breadth and depth to these subscales over those of the NEI-VFQ. The VAQ was originally developed for use with older adults, many of whom were expected to experience difficulties when driving; this will be the topic of a forthcoming manuscript. The NEI-VFQ, in contrast, probes the *amount* of difficulty an individual has performing both visual function and specific role tasks. The NEI-VFQ is unique in its assessment of patients' perceptions of ocular pain. The measure was developed for use in NEI-sponsored research across a variety of ophthalmic conditions and is not glaucoma-specific. Of the twelve available subscales, four subscales consist of a single item and four others are made up of just two items each. This brevity of item coverage may make it more difficult to assess more subtle changes in visual function over time. On the other hand, the NEI-VFQ may offer researchers the advantages of speed (it is slightly shorter than the VAQ), decreased participant burden as a consequence, and the ability to make broad comparisons to patients with many ocular conditions thanks to the measure's widespread use.

While this study brings the strength of a large sample size, we cannot conclude that our 54-month follow-up results characterize the original CIGTS population. Those whose outcomes were not available were dissimilar to the 426 whose outcomes were assessed. In general, lower socioeconomic class indicators such as income and education distinguished those whose 54-month data were not available to us. Our capture of clinical outcomes did not encompass bilateral visual measures, and so we are associating a patient-level response to a questionnaire on visual functioning with uniocular measures of visual function. It would be preferable to use results from binocular testing of VA and VF, although doing so would

overlook some intriguing inter-eye differences in associations. Finally, evaluating a subject's response to longitudinal change in visual functioning is a more definitive approach to assessing responsiveness of a questionnaire to such change than a one-time measure at 54 months. We plan to evaluate such data from the CIGTS.

In sum, clinicians and researchers interested in assessing patients' perceptions of their visual function now have several measures available to them.²⁰ These data will help provide a basis for making an informed selection if the NEI-VFQ and VAQ are being considered.

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Appendix 1

Comparison of Items and Subscales Included in the Vision-Specific QOL Measures used in the CIGTS

Visual Activities Questionnaire (VAQ)	Visual Function Questionnaire (NEI-VFQ)
<p>Acuity/Spatial Vision (n=4 items)</p> <p>I have problems reading small print (for example, phone books, newspapers).</p> <p>I have trouble reading the menu in a dimly lit restaurant.</p> <p>I have difficulty reading small print under poor lighting.</p> <p>I have difficulty doing any type of work which requires me to see well up close.</p>	<p>Near Activities (n=3 items)</p> <p>How much difficulty do you have reading ordinary print in newspapers?</p> <p>How much difficulty do you have doing work or hobbies that require you to see well up close, such as cooking, sewing, fixing things around the house, or using hand tools?</p> <p>Because of your eyesight, how much difficulty do you have finding something on a crowded shelf?</p>
<p>Color Discrimination (n=3 items)</p> <p>I tend to confuse colors.</p> <p>The color names that I use disagree with those that other people use.</p> <p>I have difficulty distinguishing between colors.</p>	<p>Color Vision (n=1 item)</p> <p>Because of your eyesight, how much difficulty do you have picking out and matching your own clothes?</p>
<p>Depth Perception (n=3 items)</p> <p>When pouring liquid, I have trouble judging the level of liquid in a container, such as the level of coffee in a cup.</p> <p>Sometimes when I reach for an object, I find that it is further away (or closer) than I thought.</p> <p>I have problems judging how close or far things are from me.</p>	

Visual Activities Questionnaire (VAQ)	Visual Function Questionnaire (NEI-VFQ)
<p>Glare Disability (n=3 items)</p> <p>I have problems with lights around me causing glare when I'm trying to see something.</p> <p>I have trouble driving when there are headlights from oncoming cars in my field of view.</p> <p>When driving at night in the rain, I have difficulty seeing the road because of headlights from oncoming cars.</p>	
<p>Light/Dark Adaptation (n=4 items)</p> <p>I have problems adjusting to bright room lighting after the room lighting has been rather dim.</p> <p>It takes me a long time to adjust to darkness after being in bright light.</p> <p>It takes me a long time to adjust to bright sunshine after I have been inside a building for a lengthy period of time.</p> <p>I have trouble adjusting from bright to dim lighting, such as when going from daylight into a dark movie theater.</p>	
<p>Peripheral Vision (n=5 items)</p> <p>I have trouble noticing things in my peripheral vision.</p> <p>I have trouble seeing moving objects coming from the side until they are right in front of me.</p> <p>When I'm walking along, I have trouble noticing objects off to the side.</p> <p>I bump into people in a busy store because I have trouble seeing them in my peripheral vision.</p> <p>I find it difficult changing lanes in traffic because I have trouble seeing cars in the next lane.</p>	<p>Peripheral Vision (n=1 item)</p> <p>Because of your eyesight, how much difficulty do you have noticing objects off to the side while you are walking along?</p>
<p>Visual Processing Speed (n=6 items)</p> <p>I have trouble reading a sign or recognizing a picture when it's moving, such as an ad on a passing bus or truck.</p> <p>When I'm driving, other cars surprise me from the side because I don't notice them until the last moment.</p> <p>I have problems carrying out activities that require a lot of visual concentration and attention.</p> <p>I have difficulty noticing when the car in front of me is speeding up or slowing down.</p> <p>When riding in a car, other cars on the road seem to be going too fast.</p> <p>It takes me a long time to get acquainted with new surroundings.</p>	

Visual Activities Questionnaire (VAQ)	Visual Function Questionnaire (NEI-VFQ)
Visual Search (n=5 items) <p>I have trouble finding a specific item on a crowded supermarket shelf.</p> <p>I have trouble locating a sign when it is surrounded by a lot of other signs.</p> <p>I have problems locating something when it is surrounded by a lot of other things.</p> <p>It takes me a long time to find an item in an unfamiliar store.</p> <p>When driving at night, objects from the side unexpectedly appear or pop up in my field of view.</p>	
General Health (n=1 item) <p>In general, would you say your overall health is excellent, very good, good, fair, poor?</p>	
General Vision (n=1 item) <p>At the present time, would you say your eyesight using both eyes (with glasses or contact lenses if you wear them) is excellent, very good, good, fair, poor?</p>	
Ocular Pain (n=2 items) <p>How much pain or discomfort have you had in and around your eyes (for example, burning, itching, or aching)?</p> <p>How much does pain or discomfort in and around your eyes, for example burning, itching, or aching, keep you from doing what you'd like to be doing?</p>	
Distance Activities (n=3 items) <p>How much difficulty do you have reading street signs or the names of stores?</p> <p>Because of your eyesight, how much difficulty do you have going down steps, stairs, or curbs in dim light or at night?</p> <p>Because of your eyesight, how much difficulty do you have going out to see movies, plays, or sports events?</p>	
Social Functioning (n=2 items) <p>Because of your eyesight, how much difficulty do you have seeing how people react to things you say?</p> <p>Because of your eyesight, how much difficulty do you have visiting with people in their homes, at parties, or in restaurants?</p>	
Mental Health (n=4 items) <p>How much of the time do you worry about your eyesight.</p>	

Visual Activities Questionnaire (VAQ)	Visual Function Questionnaire (NEI-VFQ)
	<p>I feel frustrated a lot of the time because of my eyesight.</p> <p>I have much less control over what I do because of my eyesight.</p> <p>I worry about doing things that will embarrass myself or others because of my eyesight.</p>
	<p><i>Role Difficulties (n=2 items)</i></p> <p>Do you accomplish less than you would like because of your vision?</p> <p>Are you limited in how long you can work or do other activities because of your vision?</p>
	<p><i>Dependency (n=3 items)</i></p> <p>I stay home most of the time because of my eyesight.</p> <p>Because of my eyesight, I have to rely too much on what other people tell me.</p> <p>I need a lot of help from others because of my eyesight.</p>
	<p><i>Driving (n=2 items)</i></p> <p>How much difficulty do you have driving during the daytime in familiar places?</p> <p>How much difficulty do you have driving at night?</p>

Table 1

Baseline sociodemographic and clinical characteristics of the full CIGTS sample (n=607), respondents at 54-months (n=426) and non-respondents at 54-months (n=181)

Categorical Variable	Baseline Sample (N=607)	54 Month Sample (N=426)	54 Month Non- respondents (N=181)	P-value *
	frequency (percent)	frequency (percent)	frequency (percent)	
Treatment				
Medicine	307 (50.6)	215 (50.5)	92 (50.8)	0.94
Surgery	300 (49.4)	211 (49.5)	89 (49.2)	
Sex				
Male	334 (55.0)	230 (54.0)	104 (57.5)	0.43
Female	273 (45.0)	196 (46.0)	77 (42.5)	
Race				
White	337 (55.5)	255 (59.9)	82 (45.3)	<0.01
Black	231 (38.1)	153 (35.9)	78 (43.1)	
Asian	10 (1.7)	9 (2.1)	1 (0.6)	
Other	29 (4.8)	9 (2.1)	20 (11.0)	
Education				
< High School	128 (21.1)	78 (18.3)	50 (27.6)	0.04
High School Graduate	167 (27.5)	126 (29.6)	41 (22.7)	
Some College	146 (24.1)	100 (23.5)	46 (25.4)	
College Graduate	166 (27.4)	122 (28.6)	44 (24.3)	
Household Income				
< \$20,000	191 (34.0)	121 (30.6)	70 (42.2)	<0.01
\$20,000 – \$50,000	211 (37.5)	146 (36.9)	65 (39.2)	
≥ \$50,000	160 (28.5)	129 (32.6)	31 (18.7)	
Employment				
Employed Full-Time	235 (39.2)	178 (42.2)	57 (32.0)	0.02
Employed Part-Time	58 (9.7)	43 (10.2)	15 (8.4)	
Unemployed	51 (8.5)	29 (6.9)	22 (12.4)	
Retired	185 (30.8)	126 (29.9)	59 (33.2)	
Homemaker	43 (7.2)	32 (7.6)	11 (6.2)	
Disabled	16 (2.7)	8 (1.9)	8 (4.5)	
Student	2 (0.0)	0 (0.0)	2 (1.1)	
Other	10 (1.7)	6 (1.4)	4 (2.3)	
Marital Status				
Never Married	69 (11.4)	41 (9.6)	28 (15.5)	0.04
Married	365 (60.1)	271 (63.6)	94 (51.9)	
Divorced/Separated	113 (18.6)	75 (17.6)	38 (21.0)	
Widowed	60 (9.9)	39 (9.2)	21 (11.6)	

Continuous Variable	Baseline Sample (N=607)	54 Month Sample (N=426)	54 Month Non-QOL Sample (N=181)	P-value *
	mean (std. dev.)	mean (std. dev.)	mean (std. dev.)	
Age	57.4 (10.9)	57.2 (10.8)	57.9 (11.3)	0.47
Baseline Mean Deviation	-5.46 (4.29)	-5.25 (4.26)	-6.00 (4.33)	0.06
Baseline Visual Acuity	85.7 (5.7)	86.1 (5.6)	84.8 (5.9)	0.01

* P-values derive from tests for differences in baseline characteristics between those subjects with and without 54 month follow-up information (chi-square tests for categorical variables, and t-tests for continuous variables)

Table 2

Descriptive Statistics for the Visual Activities Questionnaire and National Eye Institute-Visual Function Questionnaire and their subscales at 54-months

Instrument/Subscale	Mean	Standard Deviation	Minimum	Maximum
<i>Visual Activities Questionnaire (VAQ)</i>				
Total Score	76.4	19.2	9.1	100
Color Discrimination	87.1	19.8	0.0	100
Glare Disability	66.4	27.3	0.0	100
Light-Dark Adaptation	66.1	27.0	0.0	100
Acuity/Spatial Vision	67.7	25.2	0.0	100
Depth Perception	85.9	18.5	8.3	100
Peripheral Vision	81.5	21.3	0.0	100
Visual Search	75.7	23.3	0.0	100
Visual Processing Speed	80.1	20.0	8.3	100
<i>NEI-Visual Function Questionnaire (NEI-VFQ)</i>				
Total Score	91.7	9.0	31.5	100
General Health	68.3	23.9	0.0	100
General Vision	82.6	14.6	20.0	100
Ocular Pain	90.8	13.9	25.0	100
Near Activities	90.0	12.0	26.7	100
Distance Activities	92.5	11.1	40.0	100
Social Functioning	97.7	6.7	40.0	100
Mental Health	90.1	14.2	0.0	100
Role Difficulties	91.6	16.9	0.0	100
Dependency	95.2	12.1	0.0	100
Driving	88.6	18.6	0.0	100
Color Vision	98.1	7.2	40.0	100
Peripheral Vision	90.9	13.8	40.0	100

Table 3

Correlation matrix of VAQ and NEI-VFQ total scores and subscales at 54-month*

	VAQ Total	Color Discrimination	Glare Disability	Light-Dark Adaptation	Acuity/Spatial Vision	Depth Perception	Peripheral Vision	Visual Search	Visual Processing Speed
NEI-VFQ Total	0.70	0.44	0.49	0.53	0.62	0.66	0.67	0.60	0.66
General Health	0.36	0.24	0.22	0.27	0.38	0.35	0.33	0.28	0.36
General Vision	0.45	0.31	0.28	0.36	0.45	0.43	0.43	0.35	0.42
Ocular Pain	0.36	0.22	0.31	0.31	0.35	0.33	0.32	0.29	0.32
Near Activities	0.67	0.36	0.49	0.53	0.68	0.58	0.57	0.61	0.61
Distance Activities	0.70	0.42	0.51	0.56	0.59	0.61	0.64	0.62	0.66
Social Functioning	0.38	0.27	0.22	0.24	0.29	0.41	0.38	0.32	0.41
Mental Health	0.46	0.30	0.32	0.34	0.42	0.48	0.44	0.38	0.43
Role Difficulties	0.41	0.29	0.27	0.29	0.40	0.40	0.40	0.32	0.41
Dependency	0.34	0.24	0.21	0.23	0.31	0.37	0.32	0.30	0.33
Driving	0.56	0.34	0.43	0.44	0.47	0.53	0.54	0.50	0.53
Color Vision	0.37	0.33	0.25	0.24	0.27	0.38	0.36	0.32	0.35
Peripheral Vision	0.71	0.39	0.47	0.51	0.50	0.64	0.77	0.66	0.68

All correlations are statistically significant at the $p < .0001$ level.Note: Bold font is used for correlations ≥ 0.50

Table 4

Correlation matrix of clinical measures and functional status measures at 54-months

	Mean Deviation – Better Eye	Mean Deviation – Worse Eye	Mean Deviation Study Eye	Visual Acuity – Better Eye	Visual Acuity – Worse Eye
<i>NEI-VFQ Total</i>	0.37*	0.30*	0.29*	0.26*	0.38*
General Health	0.16*	0.12 [†]	0.11 [†]	0.12 [†]	0.18*
General Vision	0.35*	0.32*	0.30*	0.32*	0.36*
Ocular Pain	0.18*	0.13 [†]	0.13 [†]	0.12 [†]	0.11 [†]
Near Activities	0.23*	0.18*	0.18*	0.17*	0.29*
Distance Activities	0.31*	0.25*	0.24*	0.21*	0.36*
Social Functioning	0.26*	0.20*	0.18*	0.12**	0.14*
Mental Health	0.26*	0.20*	0.20*	0.15*	0.21*
Role Difficulties	0.24*	0.19*	0.17*	0.23*	0.31*
Dependency	0.30*	0.19*	0.19*	0.16*	0.28*
Driving	0.29*	0.23*	0.21*	0.24*	0.30*
Color Vision	0.23*	0.21*	0.20*	NS	0.30*
Peripheral Vision	0.22*	0.26*	0.26*	0.11 [†]	0.21*
<i>VAQ Total</i>	0.23*	0.18*	0.18*	0.10*	0.20*
Color Discrimination	0.21*	0.19*	0.20*	NS	0.10 [†]
Glare Disability	0.13 [†]	0.10 [†]	0.10 [†]	NS	0.13*
Light-Dark Adaptation	0.14*	NS	NS	NS	0.10 [†]
Acuity/Spatial Vision	0.21*	0.13 [†]	0.12*	0.16*	0.22*

	Mean Deviation – Better Eye	Mean Deviation – Worse Eye	Mean Deviation – Study Eye	Visual Acuity – Better Eye	Visual Acuity – Worse Eye
Depth Perception	0.22 [*]	0.19 [*]	0.18 [*]	0.12 [†]	0.25 [*]
Peripheral Vision	0.25 [*]	0.24 [*]	0.24 [*]	0.10 [*]	0.19 [*]
Visual Search	0.16 [*]	0.15 [*]	0.16 [*]	NS	0.14 [*]
Visual Processing Speed	0.24 [*]	0.21 [*]	0.20 [*]	0.13 [†]	0.20 [*]

[†] p<0.05

^{*} p< 0.01

Table 5

Associations of the NEI-VFQ and VAQ with visual field loss at 54 months

	MD > -2 dB Minimal VF Loss			-6 dB ≤ MD ≤ -2 dB Mild VF Loss			MD < -6 dB Moderate/Severe VF Loss			P-Value*
	N	Mean	SD	N	Mean	SD	N	Mean	SD	
NEI-VFQ Subscale										
Composite	118	93.3	6.9	131	92.2	7.7	129	87.8	12.3	<0.0001
General health	117	73.1	24.2	130	67.5	21.5	128	66.8	24.7	0.0760
General vision	118	86.1	13.2	131	84.6	12.3	129	78.1	16.3	<0.0001
Ocular pain	118	93.6	10.3	131	91.7	13.4	129	88.4	15.8	0.0079
Near activities	118	90.6	13.2	131	88.8	12.8	129	83.3	17.7	0.0003
Distance activities	118	94.1	9.4	131	92.1	11.4	129	86.3	18.1	<0.0001
Social functioning	118	98.4	5.6	131	97.7	6.7	129	95.3	11.1	0.0062
Mental health	118	91.8	11.5	131	91.9	11.7	129	86.5	18.2	0.0025
Role difficulties	118	93.4	15.7	131	92.5	15.2	129	89.3	19.1	0.1322
Dependency	118	97.2	8.2	131	95.4	9.5	129	92.8	17.0	0.0183
Driving	105	90.6	12.2	105	90.8	12.3	101	85.9	16.6	0.0163
Color vision	118	98.7	5.5	131	98.1	8.0	129	96.5	11.6	0.1229
Peripheral vision	118	92.6	14.0	131	90.6	15.3	129	83.3	19.6	<0.0001
VAQ Subscale										
Total	137	79.2	16.4	160	79.6	18.5	158	72.4	20.1	0.0006
Color discrimination	137	90.4	17.2	160	90.3	17.1	158	81.0	22.2	<0.0001
Glare disability	137	68.7	27.3	160	71.3	25.4	158	63.9	25.9	0.0391
Light/dark adaptation	137	67.9	24.5	160	68.3	27.6	158	64.8	27.7	0.4580
Acuity/spatial vision	137	70.2	24.1	160	71.1	24.6	158	64.0	26.5	0.0257
Depth perception	137	89.0	15.4	160	88.0	17.2	158	81.6	20.2	0.0005
Peripheral vision	137	85.4	17.5	160	84.5	20.4	158	76.0	21.5	<0.0001
Visual search	137	78.9	20.4	160	79.9	22.5	158	72.1	23.8	0.0041
Visual processing speed	137	82.8	18.3	160	83.2	19.0	158	75.6	21.6	0.0009

* P-values from ANOVA tests contrasting the three groups; note that a Bonferroni adjustment for multiple testing specifies an alpha level of 0.0038 (0.05/13) for significance of NEI-VFQ comparisons, and 0.0056 (0.05/9) for VAQ comparisons. Bolded p-values reflect significant differences after this adjustment.