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### Authors

Parrish, RK  
Gedde, SJ  
Scott, IU  
[et al.](#)

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## Visual Function and Quality of Life Among Patients With Glaucoma

Richard K. Parrish II, MD; Steven J. Gedde, MD; Ingrid U. Scott, MD, MPH; William J. Feuer, MS; Joyce C. Schiffman, MS; Carol M. Mangione, MD, MSPH; Alejandra Montenegro-Piniella, MD

**T**his study determines the relation between visual field impairment, visual functioning, and global quality of life in patients with glaucoma. Binocular visual field impairment was calculated from simultaneous Esterman visual field testing using the Humphrey automated perimeter. Visual acuity impairment, defined with the American Medical Association's *Guides to the Evaluation of Permanent Impairment*; visual functioning, measured with the VF-14 and the field test version of the National Eye Institute–Visual Functioning Questionnaire; and global quality of life, assessed with the Medical Outcomes Study 36-Item Short Form Health Survey, were determined in 147 consecutive patients with glaucoma. None of the Medical Outcomes Study 36-Item Short Form Health Survey domains demonstrated more than a weak correlation with visual field impairment. The VF-14 scores were moderately correlated ( $r=-0.58$ ). Of the National Eye Institute–Visual Functioning Questionnaire scales, peripheral vision ( $r=-0.60$ ), distance activities ( $r=-0.56$ ), and vision-specific dependency ( $r=-0.56$ ) were moderately correlated with visual field impairment; vision-specific social functioning, near activities, vision-specific role difficulties, general vision, vision-specific mental health, color vision, and driving were modestly correlated with visual field impairment ( $r$  value between  $-0.32$  and  $-0.55$ ); visual pain was weakly correlated with visual field impairment; and general health and vision-specific expectations were not notably correlated with visual field impairment. Statistically adjusting for visual acuity weakened the correlations. The Medical Outcomes Study 36-Item Short Form Health Survey indicated that our patients with glaucoma were comparable with previously studied patients without severe systemic medical problems. However, the Medical Outcomes Study 36-Item Short Form Health Survey scores did not correlate with visual field impairment in our study. Based on the moderate correlation between binocular visual field impairment with the VF-14 and the National Eye Institute–Visual Functioning Questionnaire, these questionnaires may be useful among patients with glaucoma.

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Studies evaluating the functional status and quality of life of ophthalmic patients have focused on the effects of cataract<sup>1-11</sup> and retinal disease.<sup>12</sup> One study evaluated “perceived visual disability” among 50 patients with primary open-angle glaucoma, but only 16 paraphrased versions of the 84 questions used were published and quality of life was not assessed.<sup>13</sup> Mills

and Drance<sup>14</sup> evaluated “perceived visual disability” among 42 patients with glaucoma, but only patients with severe visual loss from glaucoma were included; the validity and reliability of the measures of patients’ perceptions were not demonstrated.

Studies assessing visual function and quality of life among patients with glaucoma are lacking. Because glaucoma and its medical and surgical treatment may affect global quality of life as well as vision-specific functioning, the assessment of general health status and visual system health

From the Department of Ophthalmology, Bascom Palmer Eye Institute, University of Miami School of Medicine, Miami, Fla (Drs Parrish, Gedde, Scott, and Montenegro-Piniella, Mr Feuer, and Ms Schiffman); and the Department of Medicine, University of California, Los Angeles (Dr Mangione).

## PATIENTS AND METHODS

### INCLUSION AND EXCLUSION CRITERIA

The study population consisted of 147 consecutive patients recruited from the glaucoma clinic of one of us (R.K.P.) at the Department of Ophthalmology, University of Miami, Miami, Fla. Of the 151 patients who were offered participation, 4 declined enrollment. Patients with a history of laser or incisional eye surgery within 3 months before recruitment or anticipated laser or incisional eye surgery within 3 months after recruitment were excluded, as we were interested in the effect of glaucoma, rather than the short-term effect of recent or anticipated surgery, on quality of life.

### QUESTIONNAIRES

For all quality-of-life scales, the highest possible score, 100, represents the highest level of functioning or the minimal subjective impairment. The SF-36<sup>15(chap3)</sup> includes 1 multi-item scale that assesses 8 health concepts: (1) limitations in physical activities because of health problems, (2) limitations in social activities because of physical or emotional problems, (3) limitations in usual role activities because of physical health problems, (4) bodily pain, (5) general mental health (psychological distress and well-being), (6) limitations in usual role activities because of emotional problems, (7) vitality (energy and fatigue), and (8) general health perceptions. This questionnaire was chosen to assess global health-related quality of life because its validity and reliability have been demonstrated repeatedly.<sup>15(chap7-9)-31</sup> Further, comparative normative data are available for the general populations in the United States<sup>15(chap10),20,22,32,33</sup> and for patients with various medical conditions, including hypertension, congestive heart failure, type 2 diabetes mellitus, acute myocardial infarction, and clinical depression.<sup>15(chap10)</sup>

The VF-14 was developed to identify a broad spectrum of vision-dependent activities performed in everyday life that can be affected by cataract.<sup>4</sup> It was selected as one measure of patients' vision-specific functioning because it has been shown to be a reliable and valid measure of functional impairment due to cataract and provides information not conveyed by visual acuity.<sup>1,4</sup>

The 51-item field test version of the NEI-VFQ<sup>34</sup> was designed to evaluate patients' perceptions of the effect of ocular disease on daily functioning and quality of life. Unlike the VF-14, the NEI-VFQ assesses patients' abilities to perform a broader range of tasks and was designed for ophthalmic patients in general rather than for patients with cataract. The NEI-VFQ consists of the following 13 subscales: general health, general vision, visual pain, near activities, distance activities, vision-specific social functioning, vision-specific mental health, vision-specific expectations, vision-specific role difficulties, vision-specific dependency, driving, color vision, and peripheral vision.

### PROCEDURES

The study was approved by the Medical Sciences Subcommittee for the Protection of Human Subjects at the University of Miami School of Medicine. Because a considerable proportion of patients speak only Spanish, the VF-14 and NEI-VFQ were translated into Spanish<sup>35</sup> and, to ensure accuracy, translated back into English by a different translator. The SF-36 has already been published in Spanish. One hundred one patients completed the English versions, and 46 patients completed the Spanish versions.

After informed consent was obtained, each study participant was asked to self-administer the SF-36, VF-14, and NEI-VFQ questionnaires. If the patient's vision prohibited self-administration, the questionnaires were administered by a trained interviewer or a companion of the patient. Of the 147 patients, 16 (11%) required assistance. If items were left blank, our clinical coordinator telephoned the patient to obtain further information. One ophthalmologist (R.K.P.), who was unaware of the patients' questionnaire scores, performed the ophthalmologic examinations. Snellen visual acuity (with usual corrective lenses), type and duration of glaucoma, previous laser and incisional ocular surgeries for the treatment of glaucoma, number of current glaucoma medications, and comorbidities were abstracted from patients' medical records and the NEI-VFQ.

Binocular simultaneous visual field testing was performed with an automated perimeter (Humphrey Visual Field Analyzer, Humphrey Instruments, San Leandro, Calif), which was equipped with the Esterman program.<sup>14,36,37</sup> Testing was performed with patients wearing their usual contact lenses or glasses to assess everyday vision. Visual fields were

status is relevant. This study investigated (1) the association, among patients with glaucoma, between objective clinical measures of visual function (visual acuity and visual field) and 2 vision-specific functional status questionnaires (the VF-14 and the field test version of the National Eye Institute-Visual Functioning Questionnaire [NEI-VFQ]); (2) the association, among patients with glaucoma, between objective clinical measures of visual function and a general quality-of-life questionnaire (the Medical Outcomes Study 36-Item Short Form Health Survey [SF-36]); (3) the aspects of quality of life that are most affected by the visual impairment associated with glaucoma; and (4) the association between previously reported risk factors and quality-of-life questionnaires.

## RESULTS

### SUMMARY STATISTICS

**Table 1** and **Table 2** provide the clinical and demographic characteristics of the 147 study participants. The central visual acuity impairment and binocular visual field impairment of the study population are as follows:

Summary Statistic	Visual Acuity	Visual Field
Mean impairment, %	20.7*	24.5
SD of impairment	21.7	24.2
Minimum impairment, %	0	0
Maximum impairment, %	99	100

\*The asterisk indicates that this value corresponds to a visual acuity of approximately 20/45.

evaluated using the binocular Esterman visual field score because the development of this score was based on function rather than anatomy; that is, rather than all parts of the visual field being given equal value, points in the central and lower fields are represented more heavily, as these areas of the visual field are believed to be used preferentially for human activities.<sup>36</sup> For example, the Esterman visual field of a patient is shown in **Figure 1**, A; the patient's previously obtained Humphrey visual fields 24-2 are shown in Figure 1, B, and Figure 1, C. The dense nasal step of the right eye is not detected on the Esterman test. The overlapping portion of the normal nasal visual field of the left masks the defect of the right eye. A total of 102 of the 120 stimuli were seen, and the calculated Esterman efficiency score was 85. The percentage of binocular visual field impairment is calculated by subtracting the Esterman score from 100; in this example, the value equals 15%. The visual acuity impairment of the patients was calculated using the 3-step method described in the American Medical Association's *Guides to the Evaluation of Permanent Impairment*,<sup>38</sup> the accepted national standard. For these objective visual function measures, the lowest possible score, 0, represents the highest level of functioning or the minimum impairment (a visual acuity of 20/20 in each eye).

To assess nonophthalmic comorbidities, the NEI-VFQ field test<sup>35</sup> health status survey was administered. Patients were asked if they suffered from any of 16 health conditions. To assess better the effect of comorbidities on patients' functioning, a scale was added to the NEI-VFQ comorbidity assessment; for each comorbidity reported, patients were asked to specify how much that condition interfered with their activities (eg, general functioning). A comorbidity score was then assigned to each of these responses (1, not at all; 2, a little; and 3, a great deal). An overall comorbidity score for each patient was computed by summing the scores. Thus, the minimum possible comorbidity score was 0, indicating an otherwise healthy patient, and the maximum score was 48, indicating a patient with notable nonophthalmic health problems. No other attempt was made to rate the severity of the comorbidities. A similar comorbidity scale has been published previously.<sup>12</sup>

## STATISTICAL METHODS

The distribution of all variables in the study population was examined with frequency tables and summary statistics. Bivariate relationships among the dependent variables

objective visual function measures and each of the quality-of-life scales), and between the dependent variables and the continuous independent variables, were studied with scatterplots and quantified with an *r* value, the Pearson linear correlation coefficient.<sup>39(pp177-180)</sup> Spearman nonparametric correlation coefficients<sup>39(pp193-194)</sup> did not uncover, appreciably strengthen, or weaken the estimates of any bivariate relationships.

Means and SDs of each of the quality-of-life measures were obtained for each level of all ordinal and categorical variables. The association of these variables with questionnaire scores was evaluated with an analysis of variance. Because of the large number of variables, and for ease of presentation, dichotomous variables were coded as dummy variables<sup>40(pp241-256)</sup> and ordinal variables were included in these models using their ranks,<sup>41</sup> which makes the Pearson correlation equivalent to the Spearman rank correlation. The strength of the relationships between each of the quality-of-life scales and visual field impairment after adjusting for visual acuity impairment and other variables was assessed with partial correlation coefficients.<sup>40(pp265-266)</sup>

In a study of this size, even weak correlations attain statistical significance, so the *P* value does not constitute a useful measure of the importance of a relationship. Correlations were classified into ranges of importance: not statistically significant; significant, but weak,  $|r| < 0.32$  ( $r^2 < 10\%$ ) ( $P < .05$ ); modest,  $|r|$  from 0.32 to 0.55 ( $r^2$  from 10%-30%); and moderate,  $|r| > 0.55$  ( $r^2 > 30\%$ ). In the case of a dichotomous variable, such as sex, correlated with a continuous variable (any of the quality-of-life measures), the following approximate equivalence holds between the Pearson correlation coefficient, *r*, and the difference in mean values between the 2 groups, assuming equal numbers and homogeneity of variance in both groups:

$$\frac{r}{\sqrt{1-r^2}} = \frac{\text{Mean 1} - \text{Mean 2}}{2s}$$

where *s* indicates the within-group SD. Therefore, an *r* value of 0.32 ( $r^2 = 10\%$ ) corresponds to a ratio of the difference between means to the pooled sample SD of approximately 0.68, or roughly two thirds. This corresponds to a medium effect size for the comparison of 2 means in the terminology of Cohen.<sup>42</sup>

The distribution of visual field impairment scores is shown in **Figure 2**. This figure demonstrates that more than 75% of the patients had less than 50% loss of binocular visual field. The relationship between visual acuity impairment and binocular visual field impairment is demonstrated in **Figure 3** ( $r = 0.54$ ).

The mean values for the SF-36, the VF-14, and the NEI-VFQ are provided in **Table 3**. To evaluate the global quality of life of our study patients relative to other populations, we compared SF-36 scores. For each domain of the SF-36, the scores of our patients with glaucoma were within 10% of age-adjusted normal values.<sup>15(chap10)</sup> The published values for physical functioning, role-physical, and

general health scales of patients with a severe comorbid condition, congestive heart failure, were at least 20% worse than the scores of the patients in this study.<sup>15(chap10)</sup> However, values for all scales of our study patients were comparable with those of patients with hypertension, a common condition that is not usually associated with severe systemic symptoms.<sup>15(chap10)</sup>

**Table 4** provides the strength of the Pearson correlation coefficients between the clinical or demographic variables and the questionnaire scores. None of these variables was more highly correlated with any of the vision-related quality-of-life scores than was visual field or visual acuity impairment (**Table 5**).

## CORRELATIONS BETWEEN VISUAL FIELD IMPAIRMENT AND QUALITY-OF-LIFE QUESTIONNAIRES

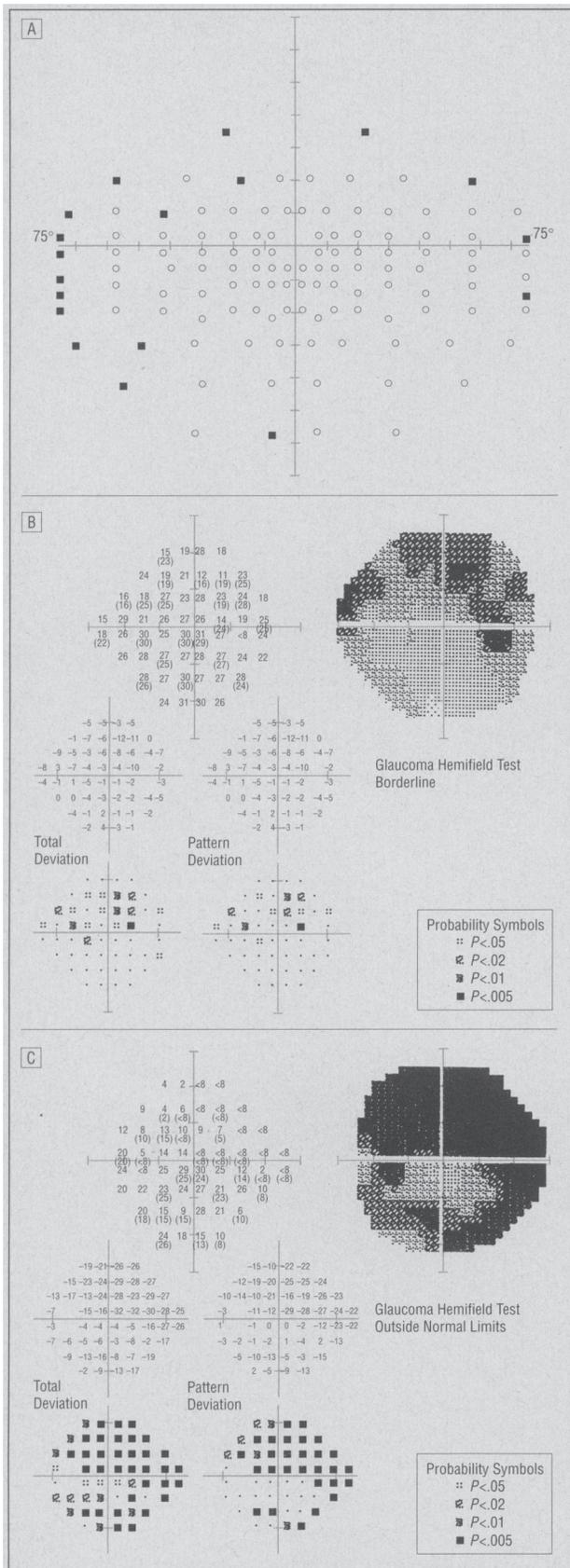
Table 5 provides the magnitude of the correlations between visual acuity impairment and visual field impairment with each of the quality-of-life questionnaires. The strongest correlations were between visual field impairment and the NEI-VFQ peripheral vision subscale ( $r=-0.60$ ), the VF-14 ( $r=-0.58$ ), the NEI-VFQ distance activities subscale ( $r=-0.56$ ), and the NEI-VFQ vision-specific dependency subscale ( $r=-0.56$ ). **Figure 4** and **Figure 5** are examples of 2 of these scatterplots. After correcting for visual acuity impairment with partial correlation methods, some of the correlations between visual field impairment and quality-of-life questionnaire scores were reduced (Table 5): NEI-VFQ peripheral vision subscale ( $r=-0.44$ ), VF-14 ( $r=-0.38$ ), NEI-VFQ distance activities subscale ( $r=-0.37$ ), and NEI-VFQ vision-specific dependency subscale ( $r=-0.35$ ). None of the 8 domains of the SF-36 demonstrated more than a weak correlation ( $|r|<0.32$ ) with visual field impairment or visual acuity impairment. Adjusting for the clinical or demographic variables in Table 4 did not appreciably change the correlations between visual field impairment scores adjusted for visual acuity and questionnaire scores ( $r^2$  changed  $\leq 0.04$ ). To indicate the effect of a unit change in visual field impairment score (percentage) on the questionnaire score, Table 3 also provides the slopes.

### COMMENT

An objective measurement of visual acuity or visual field may not accurately reflect the actual or perceived ability of the patient to function. Several suggestions have been made that visual acuity alone may be inadequate as an indicator of the degree of visual impairment. Genesky<sup>43</sup> argued that "the definition of legal blindness in this country, based so heavily on distance visual acuity, has done more harm to partially sighted people than any other definition used by our federal and state governments." Cullinan<sup>44</sup> concluded, in a survey of 193 visually disabled people in England and Wales, that the level of visual acuity provided no accurate guide to what could be achieved visually or to the extent of the handicap experienced.

### VF-14

Although the VF-14 was developed as an instrument to measure the visual functioning of patients with cataracts, the VF-14 scores of patients with glaucoma in this study were modestly correlated with visual field impairment scores, after correcting for visual acuity. Because a sufficiently large visual field may be necessary to perform many of the visually related tasks described in the VF-14, patients with substantially reduced visual fields may not have been able to perform them. Although there was a moderate correlation between visual field impairment and visual acuity impairment ( $r=0.54$ ) in this study, some patients with excellent visual acuity had high degrees of visual field impairment and others with poor visual acuity had



**Figure 1.** A, The binocular Esterman visual field of an 81-year-old man. The Humphrey efficiency score is 85, and the visual field impairment score is 15%. B, The Humphrey visual field 24-2 of the right eye of the same patient; the visual acuity is 20/20 OD (J1+). C, The Humphrey visual field 24-2 of the left eye of the same patient; the visual acuity is 20/25 OS (J1+).

**Table 1. Clinical and Demographic Variables (Continuous Variables)**

Variable	No. of Patients	Mean ( $\pm$ SD)	Median	Range
Age, y	147	70 $\pm$ 14	73	15-92
Systemic comorbidity score	147	5.0 $\pm$ 4.8	4.0	0-23
Elapsed time since the initial glaucoma treatment, mo	147	146 $\pm$ 109	120	9-568
No. of glaucoma surgeries	147	2.0 $\pm$ 1.6	2.0	0-7
Elapsed time since the last glaucoma surgery, mo	118	43.0 $\pm$ 39.0	30.4	3-235
No. of glaucoma medications (both eyes)	147	2.1 $\pm$ 1.5	2.0	0-6
Total No. of surgeries involving a conjunctival incision	147	3.0 $\pm$ 2.1	3.0	0-9

**Table 2. Clinical and Demographic Variables (Categorical Variables)\***

Variable	No. (%) of Patients (N=147)
<b>Sex</b>	
M	75 (51)
F	72 (49)
<b>Race</b>	
White (non-Hispanic)	68 (46)
Black	11 (8)
Hispanic	62 (42)
Other	6 (4)
<b>Social or living status†</b>	
Single	13 (10)
Married or living with a significant other	80 (63)
Divorced	12 (9)
Widowed	22 (17)
Nonrespondents	20
<b>Educational level†</b>	
Grade 11 or less	30 (25)
High school degree	31 (25)
Some college	24 (20)
College degree	23 (19)
Graduate degree	14 (12)
Nonrespondents	25
<b>Annual income, \$†</b>	
0-25 000	49 (47)
26 000-35 000	26 (25)
36 000-50 000	14 (13)
51 000-75 000	7 (7)
>75 000	9 (9)
Nonrespondents	42
<b>Type of glaucoma</b>	
Primary open angle alone	90 (61)
Primary angle closure	8 (5)
Pseudoexfoliation	9 (6)
Other, mixed mechanism	40 (27)
<b>Ocular involvement</b>	
Unilateral	10 (7)
Bilateral	137 (93)
<b>Severity of procedures for glaucoma</b>	
Medical therapy	29 (20)
Laser trabeculoplasty or peripheral iridectomy	20 (14)
Filter or drainage implant	94 (64)
Cyclodestructive procedure	4 (3)

\*The percentages may not total 100% because of rounding.

†The percentages are based only on the patients who responded.

relatively less impaired visual field scores (Figure 3). The VF-14 scores of patients in this study were moderately correlated with visual field impairment scores. This supports the use of the VF-14 to assess vision-specific functioning in patients with glaucoma as well as cataract.

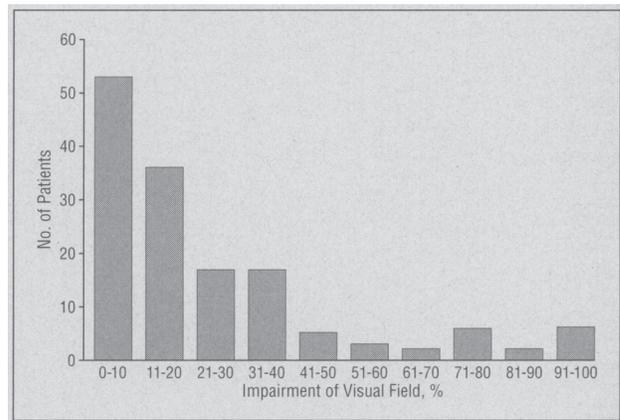


Figure 2. Distribution of visual field impairment scores.

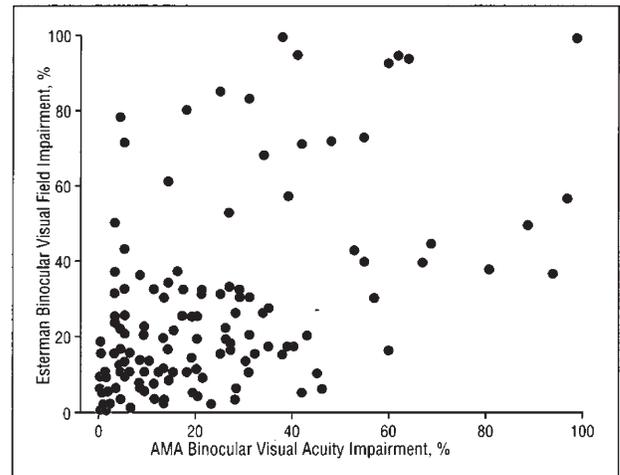


Figure 3. A scatterplot of the American Medical Association (AMA) visual acuity impairment score with the Esterman binocular visual field impairment score ( $r=0.54$ ).

**MEDICAL OUTCOMES STUDY 36-ITEM SHORT FORM HEALTH SURVEY**

The 8 domains of the SF-36 were only weakly correlated with visual acuity impairment or visual field impairment. This is not surprising considering that the SF-36 was developed as a global quality-of-life instrument rather than a disease- or organ system-specific measurement. Although the SF-36 scores were not substantively correlated with visual impairment, the comparable values of patients in this study with age-adjusted values suggest that the general health of the participants was similar to previously studied

**Table 3. Summary Statistics for the SF-36, VF-14, and NEI-VFQ Questionnaires\***

Questionnaire Scale	No. of Patients	Mean Score, %	SD	Slope†
SF-36				
PF	147	70.6	28.6	-0.30
RP	147	66.4	40.3	-0.43
BP	147	72.7	25.4	-0.07
GH	147	69.7	21.4	0.01
V	147	57.8	18.4	-0.02
SF	147	80.9	23.4	-0.17
RE	147	69.8	39.9	-0.35
MH	147	72.9	19.7	-0.01
VF-14	147	79.1	21.8	-0.52
NEI-VFQ				
GH	146	66.4	20.5	-0.10
GV	146	64.4	19.0	-0.37
VP	147	77.8	19.3	-0.15
NA	147	72.8	25.5	-0.55
DA	146	72.8	23.3	-0.54
VSSF	146	84.6	23.3	-0.50
VSMH	147	68.2	24.2	-0.47
VSE	145	48.4	19.9	-0.11
VSRD	141	75.1	26.4	-0.55
VSD	145	82.1	27.5	-0.63
D	91	71.3	24.8	-0.49
CV	147	87.8	22.0	-0.38
PV	142	69.5	30.8	-0.75

\* SF-36 indicates Medical Outcomes Study 36-Item Short Form Health Survey; NEI-VFQ, National Eye Institute-Visual Functioning Questionnaire. For the SF-36, PF indicates physical functioning; RP, role physical; BP, bodily pain; GH, general health; V, vitality; SF, social functioning; RE, role emotional; and MH, mental health. For the NEI-VFQ, GH indicates general health; GV, general vision; VP, visual pain; NA, near activities; DA, distance activities; VSSF, vision-specific social functioning; VSMH, vision-specific mental health; VSE, vision-specific expectations; VSRD, vision-specific role difficulties; VSD, vision-specific dependency; D, driving; CV, color vision; and PV, peripheral vision.

† Slope of change in questionnaire score (dependent variable) with increase in visual field impairment score.

patients and that the visual impairment of glaucoma did not contribute additional effect.<sup>15(chap10)</sup>

### NATIONAL EYE INSTITUTE-VISUAL FUNCTIONING QUESTIONNAIRE

The questions regarding peripheral vision and the subscales for distance activities, vision-specific dependency, vision-specific social functioning, near activities, vision-specific role difficulties, general vision, vision-specific mental health, color vision, and driving were at least modestly associated with visual field impairment. When corrected for visual acuity, the correlation coefficients between visual field impairment and general vision, near activities, and color vision decreased from the range of modest,  $r=0.32$  to  $r=0.55$  ( $r^2=10\%-30\%$ ) to weak,  $r<0.32$  ( $r^2<10\%$ ); general health remained not correlated. The finding that the NEI-VFQ peripheral vision, distance activities, and vision-specific dependency subscales are correlated moderately with visual field impairment supports the continued use of this questionnaire for patients with glaucoma.

### ADJUSTED ANALYSES

In this study, visual field impairment was moderately correlated with visual acuity impairment. This correlation could be due to the influence of glaucoma on both measures of visual function, the influence of some other ocular pathological features, such as cataract, or both. In the first case, the unadjusted correlations between visual field impairment and questionnaire scales are appropriate. In the second case, the relationships between questionnaire scores and visual

**Table 4. Correlations Between Clinical and Demographic Variables and the VF-14, SF-36, and NEI-VFQ\***

Clinical or Demographic Variables	VF-14	SF-36							
		PF	RP	BP	GH	V	SF	RE	MH
Age	...	1	2	...	2	...	...	...	...
Comorbidity score	...	1	...	1	1	1	...	...	2
Months since the first treatment for glaucoma	2	...	...	...	...	2	...	...	2
No. of conjunctival cutting surgeries	1	2	2	2	...	...	...	...	...
No. of glaucoma surgeries	2	...	2	2	...	...	...	...	...
Months since the last glaucoma surgery	...	...	...	...	...	...	...	...	...
No. of medications (both eyes)	...	...	...	...	...	...	...	...	...
Sex	...	...	...	...	...	...	...	...	2
Unilateral vs binocular involvement	...	...	...	...	3	...	...	...	...
Primary open-angle glaucoma‡	...	...	...	...	...	...	...	...	...
Educational status	3	...	...	...	...	...	...	...	...
Income	3	3	4	3	...	...	...	...	...
Severity of glaucoma surgery	2	...	...	...	...	...	...	...	...
Hispanic ethnicity‡	...	...	...	...	...	4	...	...	...
Living status§	...	...	...	...	...	...	...	...	...

\* Definitions for all the questionnaire scales are given in Table 3. 1 indicates a modest negative and statistically significant Pearson correlation ( $r=-0.32$  to  $-0.55$ ); 2, a weak negative and statistically significant Pearson correlation ( $r<-0.32$ ); 3, a weak positive and statistically significant Pearson correlation ( $r<0.32$ ); 4, a modest positive and statistically significant Pearson correlation ( $r=0.32$  to  $0.55$ ); and ellipses, no correlation.

† Primary open-angle glaucoma was coded as 1 and other types as 0; therefore, a negative correlation indicates that patients with primary open-angle glaucoma had a lower score on the NEI-VFQ GH scale than patients with other types of glaucoma.

‡ Hispanic ethnicity was coded as follows: Hispanic=1, and white=0. Therefore, a positive correlation indicates that Hispanics enjoyed a higher score on the SF-36 V scale than non-Hispanic whites.

§ Living status was coded as 1 if married or living with a significant other and as 0 if otherwise. Therefore, a positive correlation indicates that patients who were married or living with a significant other had higher questionnaire scores than others.

field impairment are interpreted best after adjusting for visual acuity impairment. In the third situation, neither analysis is entirely satisfactory. In this study, we have not attempted to discriminate between different causes of visual acuity impairment; in any event, the true relationship between visual field loss and the questionnaire scores will be within the bounds of the unadjusted and adjusted correlation estimates (Table 5).

No patient characteristics were more highly correlated with any of the vision-related quality-of-life measurements than was binocular visual acuity impairment itself. The age of patients in this study was correlated in the 10% to 30% range with the physical functioning domain of the SF-36. This finding is consistent with the published normative values that document decreased scores in the physical functioning domain with advancing age.<sup>15(chap10)</sup> No relationship could be defined between the number of glaucoma medications and any of the quality-of-life measurements. However, medication effects are likely to exist and may be found if sought in a systematic, prospective manner. Further statistical adjustment for patient characteristics other than visual acuity impairment did not substantially affect the correlations between visual field impairment and questionnaire scores.

#### LIMITATIONS OF THE STUDY

By the referral nature of the practice, our patients were likely to have had more severe glaucoma associated with surgical interventions than most patients with glaucoma. However, our study population includes patients with a wide range of visual field impairment, and more than half the patients had visual field

impairment scores of 20% or less. In any case, the relationship between questionnaire scores and visual field impairment seems consistent throughout the range of impairment. Also, for patients who could not self-administer the questionnaire, a companion or clinical assistant read aloud the questions and recorded the patient's responses. This technique may have introduced a bias that affected the response of the patient. However, in a previous study involving patients with glaucoma, Mills and Drance<sup>14</sup> explored this possibility by administering disability questionnaires separately to the patients and their companions. In no instance did the companion's response to the questionnaire notably disagree with that of the patient.

#### CONCLUSIONS

In this study of patients with glaucoma, the VF-14 and the NEI-VFQ, measures assessing vision-specific functioning and quality of life, were more sensitive to visual field impairment than the SF-36. The SF-36, a global quality-of-life measure, indicated that our patients with glaucoma were comparable with previously studied patients without severe systemic medical problems. Because the early stages of glaucoma usually do not produce symptoms, it is not surprising that many of the scales, either vision specific or global, did not demonstrate strong correlations with visual field or acuity impairment. Thus, the questionnaire chosen should be based on what the investigators or clinicians are most interested in knowing about their patients. For investigators interested in vision-specific functioning, the VF-14 provides a concise measure. However, a measure such as the NEI-VFQ may be more useful for investigators interested in evaluating multiple dimen-

NEI-VFQ												
GH	GV	VP	NA	DA	VSSF	VSMH	VSE	VSRD	VSD	D	CV	PV
2	...	...	...	2	...	...	...	2	...	...	...	...
1	...	2	...	2	...	...	...	...	...	...	...	...
...	2	...	2	2	2	...	2	2	...	...	...	2
...	2	2	2	1	2	1	...	2	1	1	...	1
...	2	...	2	2	2	2	...	2	1	1	...	2
...	...	...	...	...	...	...	2	...	...	...	...	...
...	...	...	...	...	2	...	...	...	...	...	...	...
3	...	...	...	...	...	...	...	...	...	...	...	...
2	...	...	...	...	...	...	2	...	...	...	...	...
...	...	3	3	3	3	3	2	...	3	...	3	...
...	...	...	3	3	3	3	2	...	3	3	...	3
...	2	...	2	2	2	2	...	2	1	2	2	1
...	...	...	...	...	...	...	3	...	...	...	...	...
...	...	...	...	3	3	...	...	3	...	...	...	...

**Table 5. Pearson Correlations (*r*) for VF-14, SF-36, and NEI-VFQ With the AMA Binocular Visual Acuity Impairment Score and Binocular Visual Field Impairment Score (Unadjusted and Adjusted)\***

Questionnaire Scale	<i>r</i>		
	AMA Visual Acuity Impairment Score	Visual Field Impairment Score	
		Unadjusted	Adjusted†
VF-14	-0.59‡	-0.58‡	-0.38§
SF-36			
PF	-0.25	-0.25	-0.14
RP	-0.24	-0.26	-0.16
BP	-0.10	-0.06	-0.01
GH	-0.08	0.02	0.07
V	0.03	-0.03	-0.06
SF	-0.13	-0.17	-0.13
RE	-0.26	-0.21	-0.09
MH	-0.10	-0.02	0.04
NEI-VFQ			
GH	-0.12	-0.12	-0.06
GV	-0.49§	-0.47§	-0.28
VP	-0.09	-0.19	-0.17
NA	-0.61‡	-0.52§	-0.28
DA	-0.57‡	-0.56‡	-0.37§
VSSF	-0.49§	-0.53§	-0.36§
VSMH	-0.41§	-0.47§	-0.32§
VSE	-0.02	-0.14	-0.15
VSRD	-0.49§	-0.50§	-0.31
VSD	-0.59‡	-0.56‡	-0.35§
D	-0.52§	-0.36§	-0.22
CV	-0.47§	-0.42§	-0.21
PV	-0.51§	-0.60‡	-0.44§

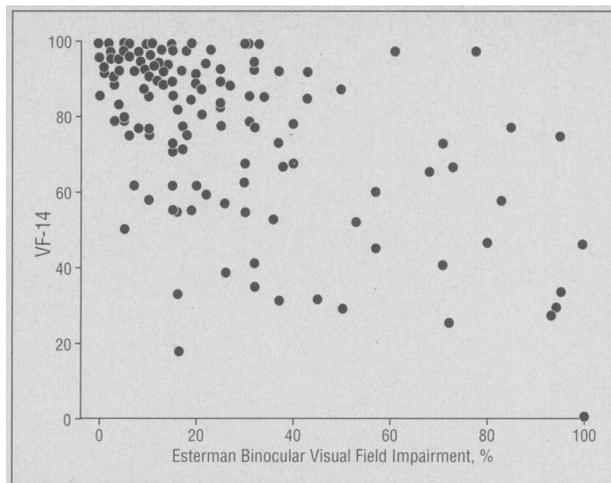
\*Definitions for all the questionnaire scales are given in Table 3. AMA indicates American Medical Association.  
 †Adjusted for the AMA visual acuity impairment score.  
 ‡Moderate correlation,  $|r| > 0.55$  ( $P < .001$ ).  
 §Modest correlation,  $0.32 \leq |r| \leq 0.55$  ( $P < .001$ ).  
 ||Weak correlation,  $|r| < 0.32$  ( $P < .05$ ).

of vision-related quality of life. An important aspect of the study is the use of the binocular visual field. Although clinicians will continue to analyze unocular visual fields to monitor glaucoma progression, we believe that the binocular visual field provides more realistic information about the visual field a patient uses for performing daily activities.

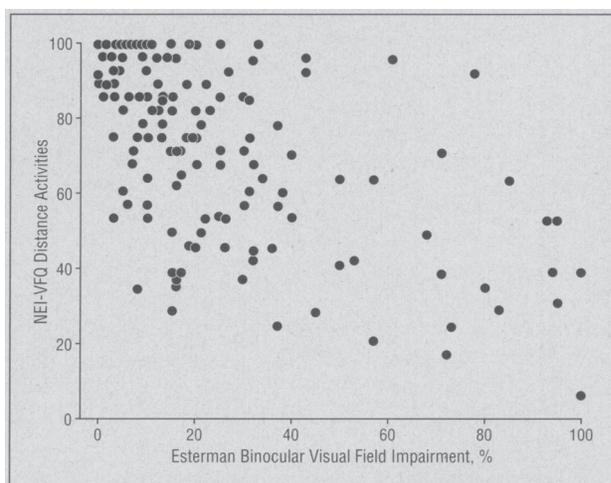
To describe quality of life among patients with severe binocular visual field loss, future research should include a larger cohort of more severely affected patients. This strategy should also further the investigation of a possible threshold of visual field impairment after which the relationship with questionnaire scores may change. If only some of the scales of the different questionnaires are proved to be valuable in defining quality of life in patients with advanced visual field loss, then a composite questionnaire of the most discriminating questions could be constructed and used to retest those with milder disease.

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**Figure 4.** A scatterplot of the Esterman binocular visual field impairment score with the VF-14 score ( $r = -0.58$ ).



**Figure 5.** A scatterplot of the Esterman binocular visual field impairment score with the National Eye Institute-Visual Functioning Questionnaire (NEI-VFQ) distance activities subscale score ( $r = -0.56$ ).

Corresponding author: Richard K. Parrish II, MD, Bascom Palmer Eye Institute, 900 NW 17th St, Miami, FL 33136.

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