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Reliability and Validity of Abbreviated Surveys Derived from the National Eye Institute Visual Function Questionnaire: The Study of Osteoporotic Fractures

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• PURPOSE: To test the reliability and validity of questionnaires shortened from the National Eye Institute 25-item Vision Function Questionnaire (NEI VFQ-25).

• DESIGN: Cross-sectional, multicenter cohort study.

• METHODS: Reliability was assessed by Cronbach α coefficients. Validity was evaluated by studying the association of vision-targeted quality-of-life composite scores with objective visual function measurements. A total of 5482 women between the ages of 65 and 100 years participated in the year-10 clinic visit in the Study of Osteoporotic Fractures (SOF). A total of 3631 women with complete data were included in the visual acuity (VA) and visual field (VF) analyses of the 9-item NEI VFQ (NEI VFQ-9), which is defined for those who care to drive, and a total of 5311 women with complete data were included in the VA and VF in the analyses of the 8-item NEI VFQ (NEI VFQ-8). To assess differences in prevalent eye diseases, which were ascertained for a random sample of SOF participants, 853 and 1237 women were included in the NEI VFQ-9 and the NEI VFQ-8 analyses, respectively.

• RESULTS: The Cronbach α coefficient for the NEI VFQ-9 scale was 0.83, and that of the NEI VFQ-8 was 0.84. Using both questionnaires, women with VA worse than 20/40 had lower composite scores compared with those with VA of 20/40 or better ($P < .001$). Participants with mild, moderate, and severe binocular VF loss had lower composite scores compared with those with no binocular VF loss ($P < .001$). Compared with women without chronic eye diseases in both eyes, women with at least 1 chronic eye disease in at least 1 eye had lower composite scores.

• CONCLUSIONS: Both questionnaires showed high reliability across items and validity with respect to clinical markers of eye disease. Future research should compare the properties of these shortened surveys with those of the NEI VFQ-25. (Am J Ophthalmol 2010;149:330–340. © 2010 by Elsevier Inc. All rights reserved.)

THE NATIONAL EYE INSTITUTE VISUAL FUNCTION Questionnaire (NEI VFQ) was devised to provide a self-reported measure of vision-targeted functioning. Originally, a 51-item questionnaire was developed,[1] and the questionnaire later was shortened to 25 items (NEI VFQ-25).[2] The instruments assess vision-related quality of life within different domains such as general, near, distance, and color vision; role limitations; dependency; mental health; and social function. They have been validated by a variety of studies showing they are useful tools in assessing vision-specific quality of life.[3–9]

One advantage of these questionnaires is their comprehensiveness, because they capture several dimensions of vision-targeted quality of life. Subscales, usually consisting of several items, can be used to provide an independent measure of visual ability within each domain.[10] The length of the surveys, however, can be a challenge, especially in large, multipurpose, population-based studies involving a variety of other questionnaires. The developers of the original NEI VFQ and the NEI VFQ-25 therefore devised a 9-item instrument (NEI VFQ-9) that has been used in the National Health and Nutrition Examination Survey since 1999. No published studies previously have assessed the reliability and validity of the NEI VFQ-9.

The NEI VFQ-9 was administered to 5482 women who participated in the year-10 clinic visit in the Study of Osteoporotic Fractures from 1997 through 1998. The purpose of this research was to evaluate the reliability and validity of the NEI VFQ-9, as well as of the 8-item NEI VFQ (NEI VFQ-8), in which the driving question is

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TABLE 1. Nine-Item National Eye Institute Visual Function Questionnaire

Nine-Item National Eye Institute Visual Function Questionnaire
Q1. General vision (6-level) At the present time, would you say your eyesight (with glasses or contact lenses, if you wear them) is: (1) excellent, (2) good, (3) fair, (4) poor, (5) very poor, or (6) are you completely blind?
Q2. Well being/mental health (5-level) How much of the time do you worry about your eyesight? (1) None of the time, (2) a little of time, (3) some of the time, (4) most of the time, or (5) all of the time.
Q3. Near vision, reading normal newsprint (6-level) How much difficulty do you have reading ordinary print in newspapers? (1) No difficulty at all, (2) a little difficulty, (3) moderate difficulty, (4) extreme difficulty, (5) stopped doing because of your eyesight, or (6) stopped doing this for other reasons or not interested in doing this.
Q4. Near vision, seeing well up close (6-level) 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? (1) No difficulty at all, (2) a little difficulty, (3) moderate difficulty, (4) extreme difficulty, (5) stopped doing because of your eyesight, or (6) stopped doing this for other reasons or not interested in doing this.
Q5. Distance vision, going down stairs at night (6-level) Because of your eyesight, how much difficulty do you have going down steps, stairs, or curbs in dim light or at night? (1) No difficulty at all, (2) a little difficulty, (3) moderate difficulty, (4) extreme difficulty, (5) stopped doing because of your eyesight, or (6) stopped doing this for other reasons or not interested in doing this.
Q6. Driving (6-level)[a] How much difficulty do you have driving during the daytime in familiar places? (1) No difficulty at all, (2) a little difficulty, (3) moderate difficulty, (4) extreme difficulty, stopped doing because of your eyesight, or (5) stopped doing this for other reasons or not interested in doing this.
Q7. Role limitation (5-level) Are you limited in how long you can walk or do other activities such as housework, child care, school, or community activities because of your vision? (1) All of the time, (2) most of the time, (3) some of the time, (4) a little of time, or (5) none of the time.
Q8. Peripheral vision (6-level) Because of your eyesight, how much difficulty do you have noticing objects off to the side while you are walking along? (1) No difficulty at all, (2) a little difficulty, (3) moderate difficulty, (4) extreme difficulty, (5) stopped doing because of your eyesight, or (6) stopped doing this for other reasons or not interested in doing this.
Q9. Near vision, finding objects on a crowded shelf (6-level) Because of your eyesight, how much difficulty do you have finding something on a crowded shelf? (1) No difficulty at all, (2) a little difficulty, (3) moderate difficulty, (4) extreme difficulty, (5) stopped doing because of your eyesight, or (6) stopped doing this for other reasons or not interested in doing this.

[a]For Question 6, "not currently driving" also was an option; however, if selected, then the question was omitted and the remaining questions comprised the 8-item National Eye Institute Visual Function Questionnaire.

excluded because of a large proportion of nondrivers and statistically significant differences between drivers and nondrivers.

METHODS

• **SUBJECTS:** From 1986 to 1988, 9704 ambulatory white female volunteers who were 65 years or older, with no history of osteoporosis or bilateral hip replacement, were enrolled in the SOF, a multicenter, prospective, longitudinal cohort study.[11] These women were located in Baltimore, Maryland; Minneapolis, Minnesota; Portland, Oregon; and the Monongahela Valley, Pennsylvania. A cohort of 662 black women was recruited from population listings at each of the 4 clinic centers using the original recruitment criteria between 1996 and 1998. From January 1997 through September 1998, all surviving participants were invited to participate in a follow-up clinical examination (year-10 clinic visit), which included a comprehensive eye evaluation. All individuals in the study gave informed consent to participate after obtaining institutional review board approvals from all study institutions. A total of 5482 women, consisting of 4820 white participants (63% of the surviving cohort) and 662 black women, attended the year-10 clinic visit. These 5482 women completed the NEI VFQ-9 questionnaire.

• **VISION-SPECIFIC QUALITY OF LIFE:** The 9-item questionnaire was devised from the NEI VFQ by the developers of the NEI VFQ using similar quantitative and qualitative analysis when developing the NEI VFQ-25. [2] With respect

to the domains represented on the 51-item version of the questionnaire, the 9-item version includes one question about the person's general vision, 3 questions about near vision (reading normal newsprint, seeing well up close, finding objects on a crowded shelf); 1 question about each of distance vision (going down stairs at night), driving (driving during the daytime in familiar places), peripheral vision (seeing objects off to the side), role limitation (limited in endurance), and well-being or mental health (amount of time worrying about eyesight); and no questions about ocular pain, vision-specific social functioning, expectations for visual function, vision-specific role-functioning, dependency because of vision, or color vision. Table 1 lists questionnaire items and the set of response options; other than a question asking whether the person is currently driving, each question includes either 5 or 6 response options. The NEI VFQ-9 takes approximately 3 to 4 minutes to complete. The questionnaire was administered using written forms that participants returned in the mail or during clinic visits. Subjects with low vision were able to seek assistance in completing the forms during their clinic visit.

• **ASSESSMENT OF VISION:** Visual acuity (VA) and visual fields (VFs) were assessed among all women who participated in the year-10 clinic visit. The presence of eye diseases, specifically age-related macular degeneration (AMD), glaucoma, and visually significant cataract, was assessed among women who were selected randomly to have their eye photographs graded.

Visual Acuity and Visual Field. Distance VA was measured in each eye separately with habitual correction using Bailey-Lovie charts,[12] and VFs[13] were assessed in each eye separately using the Humphrey Field Analyzer suprathreshold 76-point 30-degree VF program (Humphrey Field Analyzer; Zeiss, Oberkochen, Germany),[14] as described in a previous SOF publication.[15]

Eye Diseases. The presence of AMD was determined using 45-degree stereoscopic fundus photographs. Early AMD was characterized by the presence of soft drusen (drusen area $\geq$ 95 μm but $<$ 960 μm in diameter) with retinal pigment epithelium depigmentation or soft drusen (drusen area $\geq$ 960 μm in diameter) with or without pigmentary abnormalities. The presence of geographic atrophy or subfoveal choroidal neovascularization indicated the existence of late AMD.[16]

Glaucoma was diagnosed based on the appearance of the optic nerve head in the optic disc photographs and 76-point VF screening results (at least 1 point missed). Glaucomatous optic nerves were those having diffuse and localized thinning of the neuroretinal rim, loss of retinal fiber layer, increased cupping, asymmetry of the optic nerve cup-to-disc ratios of 0.2 or more, or a combination thereof.[17]

Aphakia or pseudophakia was determined for each eye using external or lens photographs, or both. Visually significant cataract was defined as the presence of nuclear, posterior subcapsular, or cortical cataract and VA worse than 20/40.[16]

The presence of a chronic eye disease was defined as (1) the presence of late AMD, or the presence of early AMD with VA worse than 20/40; (2) the presence of glaucoma; or (3) the presence of visually significant cataract, or aphakia, or pseudophakia because of cataract surgery.

• **WOMEN INCLUDED IN THE NATIONAL EYE INSTITUTE VISUAL FUNCTION QUESTIONNAIRE 9-ITEM AND 8-ITEM ANALYSES:** The distinction between the NEI VFQ-9 and NEI VFQ-8 is in their treatment of driving, which raises conceptual issues relevant to quality of life, because not everyone wants to or cares to drive. Rather than artificially assigning average quality of life, the possible quality of life, or some other quality of life to those who do not care to drive, the approach taken here is to have 2 alternate scales: the NEI VFQ-9 for those who care to drive, and the NEI VFQ-8, which is applicable to all. For those who do not care to drive, we consider their NEI VFQ-9 score to be undefined. Accordingly, in the NEI VFQ-9 instrument, subjects are asked first whether they are currently driving. For those whose response is "not currently driving," 2 additional options are provided on the reasons of not driving: stopped because of eyesight or stopped for other reasons. A person responding with the former option was coded as a nondriver and was included in the calculation of the NEI VFQ-9 composite score with the lowest possible item score (0), whereas a person responding with the latter option also was coded as a nondriver, but was considered to have an undefined NEI VFQ-9 composite score. Subjects who responded that they were completely blind were coded as nondrivers and were included in the calculation of the NEI VFQ-9 composite score with the lowest possible item score (0).

Among the 5482 women attending the SOF year-10 clinic visit in this study, 9 did not respond to the driving question. Therefore, 1793 subjects, including the 9 who did not respond to the driving question, 1563 who did not provide the reason for not driving, and 221 women who stopped for other reasons, were excluded from the calculation of the NEI VFQ-9 composite score. They were included in the calculation of the NEI VFQ-8 composite score when they responded to the other 8 NEI VFQ questions.

Among the 5482 women attending the SOF year-10 clinic visit, 8 did not return the questionnaire and were excluded from the statistical analyses, resulting in a sample of 5474 women. One additional individual did not respond to the driving question, and 1886 (34%) were coded as nondrivers. Of the 1886 women, 1563 were not currently driving without stating the reason for not driving, 221 had stopped for other reasons, 96 had stopped because of

TABLE 2. Characteristics of Women Who Participated in the Study of Osteoporotic Fractures Year-10 Clinic Visits (N = 5482)

Characteristics	Summary Statistics
No. of study sites, n (%)	
Baltimore	1279 (23%)
Minneapolis	1635 (30%)
Pittsburgh	1409 (26%)
Portland	1159 (21%)
Age (yrs) , n (%)	
Mean ± SD (range)	79.5 ± 4.5 (65 to 100)
65 to 74	382 (7%)
75 to 79	2704 (49%)
80 to 84	1655 (30%)
≥85	741 (14%)
Race/ethnicity, n (%)	
White	4820 (88%)
Black	662 (12%)
Education (yrs) , n (%)	
<12	1096 (20%)
≥12 (HS graduate or more)	4380 (80%)
Self-rated health status, n (%)	
Fair/poor/very poor	1097 (20%)
Excellent/good	4376 (80%)
No. of comorbidity (0 to 17)	
Median (range)	1 (0 to 10)
Habitual distance visual acuity in the better eye (logMAR)	
Mean ± SD (range)	0.19 ± 0.18 (−0.18 to 1.36)
Worse than 20/40	920 (17%)

HS = high school; logMAR = logarithm of the minimal angle of resolution; SD = standard deviation.

eyesight, and 6 were completely blind. Approximately 97% (5311/5474) provided valid responses to the 8 questions applicable to the NEI VFQ-8; of those who did not, 105 were drivers and 58 were nondrivers. To assess the differences in composite scores based on VA and VF, a total of 3631 women were included in the analyses of the NEI VFQ-9, and 5311 were part of the analyses of the NEI VFQ-8.

Eye diseases were diagnosed in a random sample of 1274 women of all participants in the year-10 visit. Forty-two (3.5%) women had late AMD in at least 1 eye, 513 (43.1%) had early AMD in at least 1 eye, and 634 (53.3%) women did not have AMD in either eye. A total of 105 (8.5%) had glaucoma in at least 1 eye. A total of 376 (31.7%) women had aphakia or pseudophakia in both eyes, 332 (28.0%) had visually significant cataract in at least 1 eye, and 479 (40.4%) women did not have visually significant cataract in both eyes. To assess the differences in composite scores based on prevalent eye diseases, 853 women (of 1274, or 67%) had complete data for the 9-item analysis and 1237 (of 1274, or 97%) had complete data for the 8-item analysis.

• **STATISTICAL ANALYSIS:** Distributions of demographic and health characteristics are presented for all women who participated in the year-10 clinic visit. Self-rated health status was measured by asking participants to rate their health relative to that of others as excellent, good, fair, poor, or very poor. These responses were grouped into: (1) fair, poor, or very poor; or (2) excellent or good. Participants were asked about having been told by a doctor that they have 1 or more of 17 comorbidities such as heart attack, coronary, or myocardial infarction, stroke, diabetes, high blood pressure, Parkinson disease, and dementia or Alzheimer disease.

The percentages of women with missing NEI VFQ-9 item-level responses at the missing level, or with responses at the ceiling (best possible) or floor (worst possible) levels, were calculated for the sample of women who had valid responses to all 9 questions. Individuals characterizing their vision as excellent (question 1, general vision), have a response at the ceiling level. The calculation of composite scores requires no missing values in any items.

To assess reliability, the internal consistencies of the NEI VFQ-9 and the NEI VFQ-8 were evaluated using Cronbach α coefficients.[18] The Cronbach α coefficient varies from 0 to 1; higher values indicate greater internal consistency.

Spearman correlations between VA or binocular VF and both multi-item instruments were used to assess whether people with poorer vision had lower vision-specific quality of life. Number of points missed in binocular VF loss and logarithm of the minimal angle of resolution score of VA in the better and worse eye were analyzed as continuous variables. To support validity, Spearman correlation coefficients should be negative, indicating a higher logarithm of the minimal angle of resolution score (signifying worse VA), and more points missed in binocular VF are related to lower vision-specific quality of life.

The comparison of mean NEI VFQ-9 and NEI VFQ-8 scores by VA groups (20/40 or better and worse than 20/40) and by VF groups (no binocular visual field [BVF] loss, mild BVF loss [1 to 9 points missed], moderate BVF loss [10 to 19 points missed], and severe BVF loss [20 or more points missed]) were used to assess whether statistically significant differences existed in the composite scores between people with worse vision and those with good vision.

The validity of both multi-item questionnaires using comparisons between questionnaire composite scores also was assessed based on prevalent eye diseases. To support validity, women in the reference groups comprising women with no chronic eye disease should have higher composite scores compared with those with an eye disease.

The statistical comparisons of composite scores included the following: (1) scores of women with VA 20/40 or better versus women with VA worse than 20/40 in the

TABLE 3. The Number and Percentage of Item Responses at Ceiling, Floor, or Missing for the 9-Item National Eye Institute Visual Function Questionnaire in Women Who Participated in the Study of Osteoporotic Fractures Year-10 Clinic Visits (N = 5474)[a]

9-Item National Eye Institute Visual Function Questionnaire Items	Missing, No. (%)	Floor, No. (%)	Ceiling, No. (%)
General vision			
6-level general vision	0	7 (0.1%)	817 (15%)
Near vision			
6-level reading normal newsprint	18 (0.3%)	121 (2%)	3998 (73%)
6-level seeing well up close	59 (1%)	114 (2%)	4018 (73%)
6-level finding objects on crowded shelf	13 (0.2%)	19 (0.3%)	4615 (84%)
Distance vision			
6-level going down stairs at night	94 (2%)	39 (0.7%)	3922 (72%)
Driving			
6-level daylight familiar places	1785 (33%)	102 (2%)	3484 (64%)
Peripheral vision			
6-level seeing objects off to side	9 (0.2%)	15 (0.3%)	4776 (87%)
Role limitation			
5-level limited in endurance	4 (0.1%)	74 (1%)	5030 (92%)
Well-being/mental health			
5-level amount time: worry	1 (0.02%)	234 (4%)	3644 (67%)

[a]Excluding 8 women who did not have valid responses to all 9 questions.

TABLE 4. Internal Consistency of the 9-Item National Eye Institute Visual Function Questionnaire in Women Who Participated in the Study of Osteoporotic Fractures Year-10 Clinic Visits

9-Item National Eye Institute Visual Function Questionnaire Item	National Eye Institute Visual Function Questionnaire: Cronbach α Coefficient	
	9-Item Composite Score (n = 3631)[a]	8-Item Composite Score (n = 5311)[b]
Overall	0.83	0.84
Cronbach coefficient α for deleted 9-item National Eye Institute Visual Function Questionnaire item		
General vision		
6-level general vision	0.81	0.82
Near vision		
6-level reading normal newsprint	0.80	0.80
6-level seeing well up close	0.80	0.80
6-level finding objects on crowded shelf	0.81	0.81
Distance vision		
6-level going down stairs at night	0.82	0.81
Driving		
6-level daylight familiar places	0.82	NA
Peripheral vision		
6-level seeing objects off to side	0.82	0.82
Role limitation		
5-level limited in endurance	0.82	0.83
Well-being/mental health		
5-level amount time: worry	0.85	0.86

NA = not available.

[a]Nine-item National Eye Institute Visual Function Questionnaire composite score was calculated among women who had valid responses to all 9 items.

[b]Eight-item National Eye Institute Visual Function Questionnaire composite score was calculated among women who had valid responses to all 8 items, except for the driving item.

TABLE 5. Nine-item National Eye Institute Visual Function Questionnaire Composite Scores by Clinical Measure of Visual Function in Women Who Participated in the Study of Osteoporotic Fractures Year-10 Clinic Visits

Clinical Measure of Visual Function	National Eye Institute Visual Function Questionnaire	
	9-Item Composite Score (n = 3631)[a]	8-Item Composite Score (n = 5311)[b]
Overall: mean ± SD (median)	91.3 ± 11.5 (95)	88.8 ± 13.7 (94)
Visual acuity (logMAR)		
Better eye		
Spearman correlation coefficient	−0.21	−0.24
P value	*P* < .001	*P* < .001
Mean ± SD (median)		
20/40 or better	92.6 ± 8.5 (95)	90.8 ± 10.4 (94)
Worse than 20/40	85.1 ± 17.3 (92)	80.6 ± 19.7 (89)
P value[c]	*P* < .001	*P* < .001
Worse eye		
Spearman correlation coefficient	−0.23	−0.26
P value	*P* < .001	*P* < .001
Mean ± SD (Median)		
20/40 or better	93.3 ± 8.1 (96)	91.7 ± 9.8 (95)
Worse than 20/40	89.1 ± 12.8 (94)	85.9 ± 15.5 (91)
P value[c]	*P* < .001	*P* < .001
Binocular visual field loss (number of points missed)[d]		
Spearman correlation coefficient	−0.14	−0.16
P value	*P* < .001	*P* < .001
Mean ± SD (median)		
None (no point missed)	93.6 ± 7.0 (96)	92.4 ± 8.3 (95)
Mild (1 to 9 points missed)	92.1 ± 9.2 (95)	90.9 ± 10.2 (94)
Moderate (10 to 19 points missed)	90.1 ± 11.1 (95)	88.2 ± 12.1 (93)
Severe (20 or more points missed)	87.0 ± 14.8 (92)	83.0 ± 17.6 (89)
P value[c]	*P* < .001	*P* < .001

logMAR = logarithm of the minimal angle of resolution; SD = standard deviation.

[a]National Eye Institute Visual Function Questionnaire 9-item composite score was calculated among women who had valid responses to all 9 items.

[b]National Eye Institute Visual Function Questionnaire 8-item composite score was calculated among women who had valid responses to all 8 items, except for the driving item.

[c]Kruskal-Wallis test.

[d]Binocular visual field loss were calculated among women who had reliable (fixation loss ≤ 33%) visual field test results in both eyes. Spearman correlation coefficient, −0.18 (*P* < .001) between binocular visual field loss and National Eye Institute Visual Function Questionnaire peripheral subscale.

better eye and worse eye; (2) scores of women with no binocular VF loss versus those with mild, moderate, and severe binocular VF loss; (3) scores of women without any chronic eye diseases in both eyes versus those with at least 1 eye disease in at least 1 eye; (4) scores of women without any chronic eye diseases in both eyes versus those with early or late AMD in at least 1 eye; (5) scores of women without any chronic eye diseases in both eyes versus those with glaucoma in at least 1 eye; and (6) scores of women without any chronic eye diseases in both eyes compared with phakic women with visually significant cataract in at least 1 eye and those with aphakia or pseudophakia in both eyes. The composite scores range from 0 to 100, with a score of 100 showing the highest quality of life. All statistical analyses were performed using SAS software version 9.1 (SAS Institute, Inc, Cary, North Carolina, USA). Statistical significance was defined as $P < .05$.

RESULTS

• **GENERAL CHARACTERISTICS OF PARTICIPANTS:** Table 2 presents the characteristics of the 5482 women who participated in the SOF year-10 clinic visit. The sample consisted of primarily older women; their mean age was 79.5 ± 4.5 years with a range of 65 to 100 years. Most

TABLE 6. Nine-Item National Eye Institute Visual Function Questionnaire Composite Scores by Eye Disease in Women Who Participated in the Study of Osteoporotic Fractures Year-10 Clinic Visits

Eye Disease	National Eye Institute Visual Function Questionnaire Mean ± SD (Median)	
	9-Item Composite Score (n = 853)[a]	8-Item Composite Score (n = 1237)[b]
Overall	92.1 ± 9.9 (95)	89.5 ± 12.8 (94)
Any chronic eye disease[c]		
No eye diseases in both eyes (n = 360)[c]	94.1 ± 6.2 (96; n = 259)	93.0 ± 7.4 (95; n = 351)
Yes in at least one eye (n = 838)	91.1 ± 11.2 (95; n = 549)	88.0 ± 14.3 (94; n = 811)
P-value[d]	$P = 0.005$	$P < 0.001$
Bilateral chronic eye disease (n = 556)	91.2 ± 11.8 (96; n = 353)	87.9 ± 15.2 (94; n = 534)
AMD		
No eye diseases in both eyes (n = 219)[c]	93.7 ± 6.7 (96; n = 162)	92.8 ± 7.6 (95; n = 213)
Early AMD in at least one eye (n = 513)	92.5 ± 8.9 (96; n = 343)	89.7 ± 12.6 (94; n = 495)
Late AMD in at least one eye (n = 42)	79.3 ± 23.6 (88; n = 24)	72.8 ± 26.3 (86; n = 39)
Difference (no vs late AMD)	14.4	20
P value[d]	$P = 0.003$	$P < 0.001$
Bilateral early AMD (n = 286)	92.3 ± 8.7 (95; n = 181)	89.1 ± 13.3 (94; n = 273)
Bilateral late AMD (n = 20)	73.4 ± 29.8 (86; n = 9)	62.3 ± 28.7 (59; n = 17)
Glaucoma		
No eye diseases in both eyes (n = 360)[c]	94.1 ± 6.2 (96; n = 259)	93.0 ± 7.4 (95; n = 351)
Glaucoma in at least one eye (n = 105)	92.7 ± 8.2 (96; n = 54)	85.7 ± 16.5 (93; n = 102)
P value[d]	$P = 0.609$	$P < 0.001$
Bilateral glaucoma (n = 57)	91.4 ± 9.2 (95; n = 30)	86.7 ± 14.1 (91; n = 54)
Visually significant cataract		
No eye diseases in both eyes (n = 360)[c]	94.1 ± 6.2 (96; n = 259)	93.0 ± 7.4 (95; n = 351)
Phakia with visually significant cataract in at least one eye (n = 332)	90.9 ± 10.7 (95; n = 220)	88.0 ± 12.8 (93; n = 323)
Aphakia/pseudophakia in both eyes (n = 376)	91.0 ± 12.3 (96; n = 239)	88.0 ± 15.6 (94; n = 359)
P value[d]	$P = 0.007$	$P < 0.001$
Bilateral phakia with visually significant cataract (n = 87)	93.3 ± 7.3 (96; n = 53)	88.4 ± 12.8 (94; n = 86)
Bilateral aphakia/pseudophakia or phakia with visually significant cataract (n = 517)	91.2 ± 11.8 (96; n = 330)	88.1 ± 14.9 (94; n = 495)

AMD = age-related macular degeneration; SD = standard deviation.

[a]National Eye Institute Visual Function Questionnaire 9-item composite score was calculated among women who had valid responses to all 9 items.

[b]National Eye Institute Visual Function Questionnaire 8-item composite score was calculated among women who had valid responses to all 8 items, except for the driving item.

[c]Any chronic eye disease includes age-related macular degeneration, glaucoma, and visually significant cataract.

[d]Kruskal-Wallis test.

women (4359/5482, or 79%) were between the ages of 75 and 84 years. Approximately 7% (382/5482) were in the age group 65 to 74 years, and 14% (741/5,482) were 85 years of age or older. Black women represented 12% of the sample (662/5482); the remaining were white women. Approximately 80% (4376/5482) completed high school or had higher education. The same percentage of women reported excellent or good health status. The distribution of comorbidities was skewed; the median number of comorbidities was 1, with a range of 0 to 10 (of 17 possible). Approximately 17% (920/5482) had VA worse than 20/40. In sum, the sample consisted of women who primarily were older, white, high school graduates or more, and in excellent or good self-rated health status.

• **ITEM RESPONSES:** Table 3 shows that many women performed at the optimal level for near, distance, and peripheral vision. The percentage of women reporting responses at the ceiling level exceeded 60% for all but 1 question, reaching 92% for the role limitation question. A relatively low percentage (15%) of women, however, reported that their eyesight was excellent (Table 3).

• **RELIABILITY:** The Cronbach α coefficient for the 9-item scale was 0. 83 and for the 8-item was 0.84 (Table 4). When removing questions from the scale, the α values remained relatively high, decreasing slightly for all items except for the well-being and mental health question, which if removed, resulted in Cronbach α coefficients of 0.85 for the NEI VFQ-9 and 0.86 for the NEI VFQ-8.

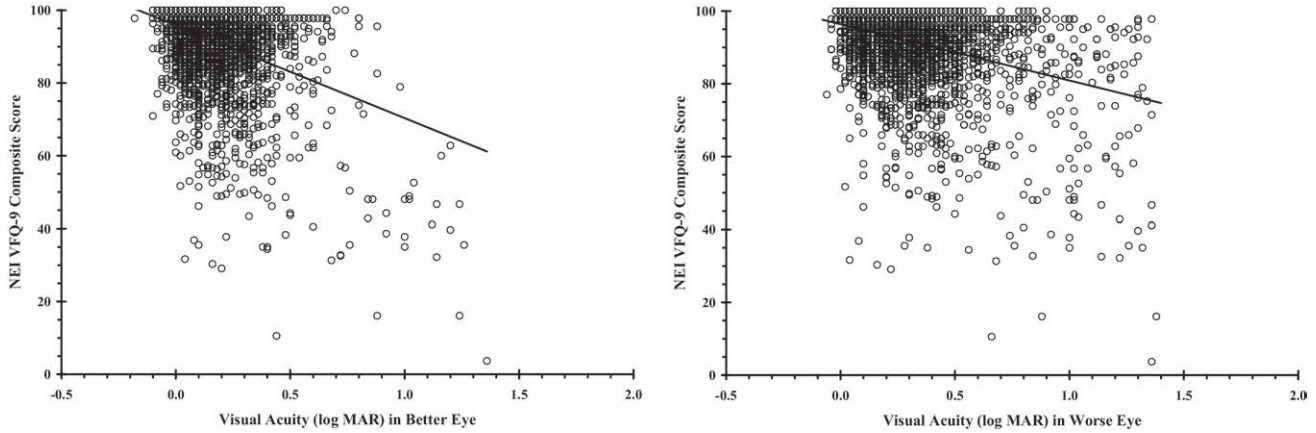

FIGURE. Scatterplots showing the 9-item National Eye Institute Visual Function Questionnaire composite score with visual acuity in logarithm of the minimal angle of resolution (logMAR) units in (Left) the better eye and (Right) the worse eye.

• **VALIDITY:** Table 5 presents the validity of both multiquestion instruments using VA and binocular VF assessments. Table 6 contains information regarding differences in prevalent eye diseases, specifically any chronic eye disease, AMD, glaucoma, and visually significant cataract.

Visual Acuity and Visual Field. Most of the 3631 subjects included in the 9-item scale analyses had high NEI VFQ scores and good VA (Figure). The mean composite score among the 3631 women was 91.3 ± 11.5, with a median of 95 (Table 5). That of the 8-item questionnaire involving 5311 women was lower (88.8 ± 13.7, with a median of 94). Women with a higher composite score of quality of life had superior VA. The Spearman correlation coefficients were relatively lower for binocular VF loss than for VA: −0.14 ($P < .001$) for the 9-item questionnaire and −0.16 for the 8-item questionnaire (Table 5). Binocular VF loss also showed similar correlation with the NEI VFQ peripheral subscale (Spearman correlation coefficient, −0.18; $P < .001$).

When binocular VF loss and VA in the worse and better eye were assessed using cutoff points, women with worse vision had lower composite scores. The differences in the groups were statistically significant for both VA and binocular VF loss for the multi-item instruments ($P < .001$). For example, there was almost a 10-point difference in the composite scores between women with no binocular VF loss (92.4 ± 8.3) compared with those with severe binocular VF loss (83.0 ± 8.3) using the NEI VFQ-8.

Eye Diseases. The mean composite score among the 853 women included in the analysis of eye diseases was 92.1 ± 9.9, with a median of 95 among women included in the NEI VFQ-9 analysis. That of the 8-item questionnaire involving 1237 women was 89.5 ± 12.8, with a median of 94. Women with at least 1 chronic eye diseases in at least 1 eye had lower composite scores compared with those with no chronic eye diseases in both eyes ($P = .005$ for NEI VFQ-9 and $P < .001$ for NEI VFQ-8). Individuals with AMD and cataract in both surveys and those with glaucoma in the NEI VFQ-8 analysis had lower composite scores compared with those without any chronic eye diseases (Table 6). The composite scores were very similar between phakic women with visually significant cataract in both eyes and those with aphakia or pseudophakia in both eyes using both instruments ($P = .585$ for NEI VFQ-9 and $P = .532$ for NEI VFQ-8).

TABLE 7. Characteristics of Drivers and Nondrivers

Characteristics	Drivers (n = 3587)	Nondrivers (n = 1886)	*P* value
Mean age ± SD (yrs)	78.8 ± 3.9	80.8 ± 5.3	< .0001
Self-rated health status, n (%)			< .0001
Fair/poor/very poor	563 (16%)	531 (28%)	
Excellent/good	3022 (84%)	1348 (72%)	
Mean NEI VFQ-8 composite score ± SD	91.6 ± 9.2	83.3 ± 18.6	< .0001

NEI VFQ-8 = 8-item National Eye Institute Visual Function Questionnaire; SD = standard deviation.

Drivers Versus Nondrivers. Drivers had a higher than average NEI VFQ-8 composite score of 91.6 ± 9.2 (median, 94) compared with 83.3 ± 18.6 (median, 91) in nondrivers ($P < .001$; Table 7). Among nondrivers, glaucoma patients had significantly lower scores on the NEI VFQ-8 distance vision ($P = .003$) and peripheral vision ($P = .024$) questions than nonglaucoma subjects. Glaucoma patients who did not drive also had lower scores on the other 6 NEI VFQ nondriving questions than nonglaucoma subjects who did not drive, although the differences were not statistically significant.

DISCUSSION

OVERALL, THE 2 SHORTENED VERSIONS OF THE NEI VFQ yielded similar results. Both the NEI VFQ-9 and NEI VFQ-8 showed high reliability across items and validity with respect to clinical markers of eye disease in a cohort of older women with an average age of 80 years. Women with severe binocular VF loss and VA worse than 20/40 in the better and worse eyes had lower composite scores compared with those with no VF loss and those with VA 20/40 or better. Between-group differences in composite scores in people with a particular eye disease versus those without any chronic eye diseases indicated that people with eye diseases had lower composite scores, except in the case of drivers with glaucoma.

Our primary goal was to assess the NEI VFQ-9, which is being used in the National Health and Nutrition Examination Survey. Researchers face a similar challenge when there is a high percentage of nondrivers in the study population in using both the NEI VFQ-25 and NEI VFQ-9. We recommend reporting findings related to both the NEI VFQ-9 and NEI VFQ-8 when a high proportion of nondrivers exists, as in this study. Reporting findings for both questionnaires may provide more information because drivers and nondrivers have different characteristics. The population of individuals included in the 8-item questionnaire tended to consist of people with poorer health, which may be because nondrivers lack independence and have reduced physical and visual functioning. Drivers were younger and had better self-rated health status. In addition, the decision regarding which of the 2 shortened questionnaires to use may depend on the proportion of nondrivers in the study population. The percentage of older persons licensed to drive is increasing at the present time compared with past years,[19,20] largely because of more older women driving.[21] At the same time, the number of persons not driving increases with advancing age. In the SOF population, approximately one third of individuals were nondrivers, compared with 16% in a sample consisting of relatively younger people in the study of Mangione and associates introducing the NEI VFQ-25.[2]

It is arguable whether the changes in composite scores between people with vision problems compared with those with no vision problems are clinically relevant. The Submacular Surgery Trials Research Group found that a 4-point difference in the overall NEI VFQ-25 and a 5-point subscale change constitute a minimum clinically relevant change.[22] Based on a 5-point change criterion, minimum clinically relevant changes were detected between: (1) women with VA 20/40 or better in the better eye and those with VA worse than 20/40, (2) women with no binocular VF loss and those with severe loss, and (3) participants with no AMD in both eyes and those with late AMD in at least 1 eye, using both questionnaires. Minimal clinical significant changes were observed more frequently when using the NEI VFQ-8 compared with the NEI VFQ-9, which may be because the women who completed all 9 questions represented a healthier population.

There were greater decreases in quality-of-life composite scores in women with glaucoma when using the NEI VFQ-8 compared with the NEI VFQ-9, and the declines using the NEI VFQ-9 had borderline significance. When removing the driving question, results were consistent with past research showing that patients with glaucoma have a decreased quality of life. The NEI VFQ is considered the standard for assessing the quality of life in glaucoma patients.[23] In a recent publication of the Los Angeles Latino Eye Study, glaucoma patients with VF loss had lower NEI VFQ-25 scores compared with glaucoma patients without VF loss.[24] Using the NEI VFQ-25 and involving 5213 subjects, the Los Angeles Latino Eye Study reported that VF loss was associated with driving difficulties,[25] and the Advanced Glaucoma Intervention study found that patients with glaucoma reported greater driving difficulties than those without glaucoma.[26] One explanation for the moderate decreases in quality of life in glaucoma patients who drove in this study may be that many individuals with glaucoma chose not to drive because of their glaucoma. Another interpretation is that people whose vision was intact to the extent where they could drive were not affected by glaucoma in terms of quality of life at the time they completed the questionnaire. People with glaucoma may still perform well on vision-related tasks during the early stages of the disease. A study using the NEI VFQ reported a modest correlation between VF loss and driving ability among glaucoma patients.[27] An investigation of 35 glaucoma patients found that lower contrast sensitivity, and not mild or moderate VF loss, was associated with decreased driving performance, which was evaluated using driving simulation and self-report of past driving accidents.[28] In another study also using driving simulation and self-report of past driving accidents, reductions in the VF to less than 100 degrees of horizontal extent were related to worse driving performance,[29] indicating that more severe declines in VF may affect driving performance.

A surprising finding is that phakic women with visually significant cataract in both eyes and those with aphakia or pseudophakia in both eyes had very similar vision-specific quality of life composite scores. In subanalysis, there were no statistically significant differences in NEI VFQ-9 ($P = .585$) and NEI VFQ-8 ($P = .532$) scores between patients with visually significant cataracts in both eyes and those with aphakia or pseudophakia in both eyes. Using the Activities of Daily Vision Scale, Mangione and associates reported improved scores 12 months after cataract extraction.[30] The results in this study may be the result of people with cataract surgery being older, having better vision in 1 eye, or other factors affecting their vision. The finding that those with cataract have a lower vision-specific quality of life compared with those with no cataract was consistent with past research.[9]

In terms of AMD, the differences in composite scores were slight between women with no AMD and early AMD but those between women with no and late AMD were as many as 20 points. The finding is not surprising given the great severity of late AMD; the progressive loss of central vision adversely affects quality of life.[31] In a literature review of studies using the NEI VFQ-25, Finger and associates found that AMD adversely affected vision-specific quality of life.[32]

Strengths of this study include its large sample size, high overall response rate, and assessment of VA and VF using standardized methods among all participants. Another strength is the incorporation of binocular VF assessment.[17] Although VA has been found to be the most important determinant of the NEI VFQ score,[10] it provides only a limited measure of vision performance. A linear association between inferior NEI VFQ-25 scores and VF declines existed in Los Angeles Latino Eye Study.[25]

The study population comprised older women initially living in communities; therefore, the results may not apply to other populations such as men, younger women, or those with poorer health or living in institutions. The sample represents a relatively healthy, motivated, and educated population. Because this is a cross-sectional study, the authors could not evaluate changes in vision and quality of life over time. The administration of the NEI VFQ abbreviated questionnaires may be feasible in large multipurpose population-based studies, although our findings do not address whether the NEI VFQ-25 can be replaced by the short questionnaires. The reliability and validity of NEI VFQ-9 and NEI VFQ-8 could not be compared with those of the NEI VFQ-25 in this study because SOF participants did not complete the longer questionnaire. Our study did not evaluate the usefulness of the brief questionnaires in clinical trials. Some driving seniors are reluctant to report they are driving because of fear that the response will be transmitted to the licensing authorities, resulting in the loss of permission to drive; therefore, there may be a misclassification of driving status in this study. In addition, some of the missing data for the reason for not driving may be because of response options being embedded in the question on the difficulty of driving. A smaller subset of women was used in the analyses of eye diseases; however, the subset was a random sample of all participants in the study. Differences in prevalent eye diseases by the severity of the disease were not assessed. Although the assessment of binocular VF loss using the Esterman scoring algorithm[15] calculations may be a limitation, results from calculated binocular VF are comparable with the results of the Esterman binocular VF test.[33–36] Other analyses of NEI VFQ-8 and NEI VFQ-9 data are possible, including a Rasch-model analysis that could be used to scrutinize the extent to which items conform to a single latent-variable construct.[37] We regard such an approach as potentially interesting but beyond the scope of the present research, because in general, attempting to determine the latent variable structure among multivariate measurements is more involved than evaluating reliability and validity of a specific composite measure.

In conclusion, both questionnaires showed high reliability and validity with respect to clinically relevant markers. Longer surveys could result in a poorer response rate, which in turn could affect validity.[38] In systematic reviews of randomized trials using postal surveys,[39–40] higher response rates were seen when shorter questionnaires were used. Future research should compare the properties of the shortened surveys with those of the NEI VFQ-25.

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