Associations Between Self-Rated Vision Score, Vision Tests, and Self-Reported Visual Function in the Salisbury Eye Evaluation Study

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PURPOSE. We attempt to understand the determinants of self-rated vision status by examining associations with vision tests, self-reported visual function, demographic, and health-status characteristics.

METHODS. Participants included 2467 individuals, aged 65 to 84 years, in a longitudinal, population-based cohort study. Participants rated their vision status from 0 to 10. Visual acuity, contrast sensitivity, stereoacuity, and visual fields were assessed. The Activities of Daily Vision Scale (ADVS) questionnaire was administered. Multivariate ordinal and multinomial logistic-regression models examined the association of demographic, health-status characteristics, vision tests, and ADVS subscales with self-rated vision status score. Odds ratios described the association of these characteristics with reporting better vision status.

RESULTS. Better visual acuity, contrast sensitivity, stereoacuity, and visual fields were associated with increased odds of reporting better vision status. Among the vision tests, a 2-line increase in visual acuity was most likely to result in an individual reporting better vision status (odds ratio, 1.49; 95% confidence interval [CI], 1.30–1.70). A 5-point increase in the near vision and far vision ADVS subscale scores was associated with increased odds of reporting good versus poor vision status. A 5-point increase in the near vision subscale was most likely to result in an individual reporting good versus poor vision status (odds ratio, 1.38; 95% CI, 1.28–1.50).

CONCLUSIONS. Self-rated vision status is a multidimensional measure. Near-vision visual function, visual acuity, and contrast sensitivity are important determinants of self-rated vision status in an elderly population. This understanding may improve the ability of eye care providers to maximize self-rated vision status among their patients.

Keywords: self-rated vision, visual function, elderly, vision tests

Self-reported data are used widely in national surveillance surveys, clinical and population based studies, and routine clinical assessments to assess vision status, eye disease, and visual function.¹ A number of surveys ask participants to rate the global quality of their vision on a scale from poor to good (self-rated vision status). In routine clinic assessments, patients also are often asked how they would rate their vision. This measure usually is taken as a surrogate for a patient's overall satisfaction with their vision. Understanding which variables are most important to individuals as they rate their vision status is important not only in further understanding the determinants of this measure, but also in ultimately improving an individual's self-rated vision status and their overall satisfaction with their vision.

Previous studies have examined the association between self-rated vision status and vision tests (visual acuity, contrast sensitivity, and visual fields), although some of the results have been inconsistent. The 25-item National Eye Institute Visual Function Questionnaire (NEI VFQ-25) asks participants their self-rated vision status in the general vision subscale.² This subscale has been associated significantly with visual acuity in multiple populations.^{2–8} Other vision tests, such as contrast

sensitivity, stereoacuity, and visual fields, also may be important determinants in self-rated vision status.^{9–13} However, the association among these measures and self-rated vision status has not been well studied. In the populations in which it has been examined the results have been inconsistent. For example, Revicki et al.⁷ found that the correlation between the general vision subscale of the NEI VFQ-25 and contrast sensitivity was not significant in a population of age-related macular degeneration patients. Noble et al.¹⁴ found a similar result in a population of multiple sclerosis patients. In contrast with these findings, other studies have described a significant correlation between self-rated vision status and contrast sensitivity in a population of glaucoma and optic neuritis patients.^{4,5} Similarly, other reports have been inconsistent regarding the association between self-rated vision status and visual fields.^{2,4,10,14} Few studies have examined the association between self-rated vision status and stereoacuity. Therefore, it is clear that further study is needed to elucidate more firmly the relationship between self-rated vision status and vision tests.

Vision tests alone do not entirely reflect the degree of visual impairment experienced by an individual.^{15,16} Measures that evaluate visual function provide additional information about

the impact of visual impairment on everyday life, and thus, visual function also may be an important determinant of self-rated vision status. Few studies have examined the association between self-rated vision status and visual function.

The aim of our study is to evaluate the association between self-rated vision status, and tests of visual acuity, contrast sensitivity, stereoacuity, bilateral visual field, as well as self-reported visual function in specific domains of near and far vision. The goal is to understand better which variables are most important when participants rate the quality of their vision.

METHODS

Subjects

The study sample consisted of 2467 individuals enrolled in the Salisbury Eye Evaluation (SEE) Study. The Johns Hopkins Institutional Review Board approved all protocols. Data collection began in 1993. All subjects gave written informed consent before participation. All subjects were treated in accordance with the Declaration of Helsinki. A detailed description of the sampling procedure has been described previously.^{17,18} Briefly, the sample was selected from the Health Care Financing Administration (HCFA) Medicare eligibility list, and included only individuals between 65 and 84 years of age as of July 1, 1993 living in the Salisbury, Maryland metropolitan area. This sample included 100% of identified African American residents and a random age-stratified sample of 58% of identified white residents. No other ethnic groups were on the list. To be eligible for the study, the participant had to be able to travel to the clinic for vision tests and score greater than a 17 on the Mini-Mental Status Exam (MMSE).¹⁹ Eligible participants participated in a 2-hour in-home interview followed by a 4- to 5-hour clinic examination. Of those who were eligible, 65% participated. Details on the differences between participants and refusals have been described previously.¹⁸

Self-Rated Vision Status and Baseline Variables

Demographic characteristics were collected from the Social Security Administration records. Participants were asked how they would rate their current vision with glasses on, if they wore glasses, on a scale of 0 = blindness to 10 = excellent vision (self-rated vision status). The MMSE also was administered, as well as a standardized home questionnaire that included sections on years of education received, and self-reported visual function on a variety of visual tasks (Activities of Daily Vision Scale [ADVS]). The clinical examination included an assessment of depression using the depression scale of the General Health Questionnaire and vision testing.

Visual Acuity

Detailed descriptions of the vision tests have been reported previously.¹⁷ Trained technicians using strict forced-choice testing procedures administered all vision tests.

Distance visual acuity was tested using the Early Treatment Diabetic Retinopathy Study (ETDRS) charts.²⁰ The acuity charts were transilluminated with a light box (The Lighthouse, New York, NY) that maintains chart luminance at 130 cd/m². Acuity was measured monocularly and binocularly, with habitual refractive correction and best correction after subjective refraction. Visual acuity was scored as the total number of letters read correctly and converted to log₁₀ minimum angle resolution (logMAR).²¹ Participants who failed to read any

letters were assigned arbitrarily an acuity of 1.7 logMAR (20/1000).

Contrast Sensitivity

Contrast sensitivity was measured with the Pelli-Robson letter sensitivity test.²² The test was administered at 1 m under controlled room illumination (~100 cd/m²). Contrast sensitivity was scored letter by letter.²³

Stereoacuity

Stereoacuity was tested with the Randot Circles test (Stereo Optical, Inc., Chicago, IL). The test consists of a series of 10 panels that form a graded disparity series from a maximum of 457 to a minimum of 17 seconds of arc when viewed at a distance of 36 cm. The panels were tested in order, beginning with the largest disparity and continuing until there was an incorrect response. The participant's score was the disparity (in log₁₀ seconds of arc visual angle) of the panel before the first incorrect response.

Visual Fields

Visual fields were tested separately for each eye using the 81-point, single-intensity screening test strategy on a field analyzer (Humphrey Systems, San Leandro, CA). This strategy tests points in a 60° (radius) field with a single target intensity of 24 dB. If the fixation losses, false-negative responses, or false-positive responses exceeded 20%, the test was stopped and the participant re-instructed before undertaking a new test. Field tests were scored by counting separately the number of points missed in the central 30° and peripheral 30°. The square root of the number of points missed was used for analysis.

Visual Disability Questionnaire

Visual function was assessed during the home interview with the ADVS, a forerunner to the NEI-VFQ.²⁴ The original ADVS is a 22-item questionnaire used to assess difficulty performing a range of vision tasks that were judged to be important to patients with cataract. It includes 5 subscales, including near vision, far vision, day driving, night driving, and glare. Trained interviewers administered the ADVS as originally published, excluding one question on the use of bus service, which was not available in Salisbury. For each item, it was determined whether the participant had done the activity within the past 3 months and, if not, whether it was because of vision problems. Activities that had not been engaged in recently for reasons unrelated to vision were not scored. The remaining items were scored according to level of difficulty: 1, unable to perform because of vision problems; 2, extreme difficulty; 3, moderate difficulty; 4, a little difficulty; and 5, no difficulty. For each subscale, all recorded activity scores were averaged eliminating activities not participated in for reasons other than vision. Then, the average subscale scores were rescaled to a range of 0 to 100, with 0 denoting responses of "unable to do due to vision" on all scored activities and 100 denoting responses of "no difficulty" on all scored activities.

We have published previously an evaluation of the psychometric properties of the ADVS based on data from the SEE study.²⁵ Our study determined that the overall ADVS scale, and night-driving, near-vision, and far-vision subscales exhibit adequate content validity, internal consistency, and discriminability. Our validation study determined that the original day-driving and glare subscales had insufficient internal consistency and were limited by items that were not applicable to a large

FIGURE 1. Histogram of self-reported vision status score.

proportion of our participants. These two subscales were not used in the analyses.

Furthermore, the measurement properties and construct validity of the ADVS for low-vision patients has been examined previously using Muraki's IRT-based rating scale model and Andrich's Rasch-based rating scale model. The ADVS makes valid functional ability measures in low vision patients.^{26,27}

Data Analysis

The distribution of the self-rated vision status score was highly skewed. A histogram of the self-rated vision status score is shown in Figure 1. For analysis purposes, the score was transformed into an ordinal variable. Visual inspection of the score distribution suggested cutoff values of <5 and >7 , creating three grade score categories of 0 to 4 (poor vision status), 5 to 7 (fair vision status), and 8 to 10 (good vision status). Ordinal logistic regression models, using these 3 categories as the outcome, were used to examine the relationship between self-rated vision status, health status and demographic characteristics, and vision tests. The proportional odds assumption was checked using the self-rated vision status score χ^2 test to ensure that the models were appropriate. However, the proportional odds assumption did not hold when the activities of daily vision subscales were used as explanatory variables. In this case multinomial logistic regression models were used instead. The strength of the association is presented as odds ratios and 95% confidence intervals (CI). A change of 1 SD was chosen to report the magnitude when the data on an explanatory variable were continuous. The models were built using a backward elimination strategy: we started with models including all the prespecified variables that potentially were related to the outcome. That is, in addition to the vision-related variables, the initial models always included age, sex, race, education, presence of symptoms of severe depression, MMSE score, and number of comorbid conditions. Among variables whose P value was greater than 0.05, we removed from the model the one that had the highest P value. To create a parsimonious model, we proceeded iteratively until all variables in the model had associated P values of 0.05 or less.

RESULTS

The characteristics of the study population were examined by categories of self-rated vision status score (Table 1). A lower percentage of participants who reported good vision status were female or black compared to participants who reported worse vision status (score < 8). These participants also were

on average younger, had more years of education, had a better MMSE score and reported less comorbidities and symptoms of severe depression than those who reported worse vision status. Those who reported good vision status had on average better presenting visual acuity, contrast sensitivity, stereoacuity, and bilateral visual fields than participants who reported worse vision status. They also had on average higher ADVS subscale scores in the near vision, far vision, and night driving domains. The above held true when comparing the characteristics of those who reported fair vision status to those who reported poor vision status.

A multivariate ordinal logistic regression model examined the association of demographic, health status characteristics, and vision tests with self-rated vision status, controlling for demographic and nonvision health status characteristics (Table 2). Better visual acuity, contrast sensitivity, stereoacuity, and bilateral visual fields increased the odds of reporting better vision status. When comparing the impact of the various vision tests on vision status score, a 1 SD increase in visual acuity increased the odds of reporting better vision status by almost 50% followed by contrast sensitivity, which increased the odds by 34% per 1 SD increase. This was followed by stereoacuity and bilateral visual field, which increased the odds by 28% and 11% per 1 SD increase, respectively. Interestingly, a number of nonvision-related factors also were independently related to self-rated vision status score. Being female, having symptoms of severe depression, a per unit decrease in MMSE score, and a per unit increase in the number of comorbid conditions increased the odds of reporting worse vision status. Race, age, and years of education received were not associated with self-rated vision status once other factors were in the model.

Next, we examined the association of demographic, health status characteristics, and the functional impact of a decrease in vision, as represented by the ADVS subscales, with vision status score controlling for demographic and nonvision health status characteristics (Table 3). Self-reported difficulties on near and far vision ADVS subscales were associated significantly with self-rated vision status score. A 5-point increase in near and far vision ADVS subscales increased the odds of reporting good versus poor vision status by 38% and 20%, respectively. Furthermore, a 5-point increase in the near vision ADVS subscale also increased the odds of reporting fair versus poor vision status by 11%. The night-driving subscale was not associated significantly with vision status score.

In this model, a per unit increase in age and a per unit decrease in MMSE score increased the odds of reporting poor versus good vision status. However, unlike the vision test model, being female, a per unit increase in the number of comorbid conditions, and being depressed did not contribute

TABLE 1. Characteristics of the Study Population by Categories of Self-Rated Vision Status Score

	Vision Status Score			Age-Adjusted P Value*
	0–4, N = 128	5–7, N = 774	8–10, N = 1565	
Demographics				
Mean age in y (SD)	75.9 (5.7)	74.3 (5.3)	72.9 (4.8)	<0.001
% Females	62.5	60.1	55.5	0.05
% Blacks	32.8	26.9	24.4	0.02
Mean y of education (SD)	10.0 (3.7)	10.9 (3.3)	11.5 (3.4)	<0.001
Health status				
Mean MMSE (SD)	25.9 (3.0)	26.9 (2.7)	27.5 (2.4)	<0.001
% Severe depression symptoms	16.7	12.6	6.9	<0.001
Mean N of comorbidities (SD)	2.7 (1.6)	2.6 (1.7)	2.2 (1.5)	<0.001
Vision tests				
Mean logMar presenting visual acuity (SD)	0.34 (0.49)	0.07 (0.19)	−0.01 (0.13)	<0.001
Mean contrast sensitivity, no. of letters (SD)	28.7 (10.0)	34.0 (3.9)	35.5 (3.0)	<0.001
Mean log stereo acuity (SD)	2.4 (0.59)	2.1 (0.55)	1.8 (0.44)	<0.001
Mean points missing bilateral visual field (SD)	37.6 (28.3)	29.5 (18.6)	22.4 (14.5)	<0.001
Mean activities of daily vision subscales (SD)				
Near vision	62.2 (33.7)	86.7 (17.1)	96.0 (7.5)	<0.001
Far vision	68.7 (30.6)	88.1 (15.7)	96.1 (7.8)	<0.001
Night driving	41.8 (40.8)	65.7 (32.7)	82.5 (23.7)	<0.001

* From an ordinal logistic regression model, including age and the characteristic of interest.

to self-rated vision status, once the model included self-reported visual function.

DISCUSSION

The purpose of our study was to understand further the determinants of self-rated vision status and what variables are most important to individuals as they rate the global quality of their vision. What we found is that multiple components are related to this simple measure. First, multiple vision tests are significant determinants of self-rated vision status. Consistent with previous studies, better visual acuity, contrast sensitivity, and bilateral visual fields were associated significantly with reporting better vision status even when demographic factors, cognitive status, depression, and a number of other chronic medical conditions were considered.^{2–8,10,14} Few studies had previously examined the association between stereoacuity and self-rated vision status. In our study population, stereoacuity

also was associated significantly with self-rated vision status. Although better performance on all the vision tests was associated independently with reporting better vision status, better distance visual acuity followed by contrast sensitivity were most important in increasing the odds of reporting better vision status.

When thinking about why visual acuity and contrast sensitivity were the most important determinants for self-rated vision status, it is important to recognize that previous studies have demonstrated the importance of visual acuity and contrast sensitivity in visual function.^{11–13,28–31} Furthermore, studies have emphasized particularly the importance of visual function in an individual's perception of vision status.^{32–36} Therefore, it is likely that the association of vision tests and self-rated vision status is, in part, by way of visual function (Fig. 2). It has been demonstrated previously in our study population that improvements in all of the vision tests were associated with an increase in the odds of being high functioning versus low functioning.³⁷ Consistent with other studies, better visual

TABLE 2. Demographic, Health Status, and Vision Tests Associated With Self-Rated Vision Status Score

Characteristic	Odds Ratio (95% CI)*	P Value
Demographic and health status		
Female	0.82 (0.68–0.98)	0.025
Symptoms of severe depression	0.71 (0.53–0.95)	0.022
MMSE, per unit decrease	0.96 (0.93–0.99)	0.024
N of comorbid conditions, per unit increase	0.89 (0.84–0.94)	<0.0001
Vision tests		
Visual acuity, per 1 SD approximately 2 lines increase†	1.49 (1.30–1.70)	<0.0001
Contrast sensitivity, per 1 SD approximately 4 letters increase†	1.34 (1.18–1.54)	<0.0001
Stereo acuity, per 1 SD approximately 0.5 log units increase†	1.28 (1.16–1.42)	<0.0001
Gaining points bilateral visual field, per 1 SD approximately 17 points†	1.11 (1.01–1.23)	0.036

Multivariate model from ordinal logistic regression models with vision status score (0–10), categorized as poor (0–4), fair (5–7), and good (8–10). Score test for the proportional Odds Assumption: $\chi^2 = 7.37$, degrees of freedom 8, $P = 0.50$.

* For change of 1 SD using standardized scores.

† Odds ratio associated with reporting better vision, moving from a vision status score of poor (0–4) to fair (5–7), or fair (5–7) to good (8–10).

TABLE 3. Demographic, Health Status, and Activities of Daily Vision Subscales Associated With Self-Rated Vision Status Score

	Odds Ratio (95% CI)*		P Value†
	Vision Status Score 8–10	Vision Status Score 5–7	
Demographic and health status			
Age, per y increase	0.95 (0.91–0.97)	0.98 (0.94–1.02)	0.004
MMSE, per unit decrease	0.89 (0.82–0.96)	0.96 (0.89–1.03)	0.0001
Activities of daily vision subscales			
Near vision subscale, per 5 points increase	1.38 (1.28–1.50)	1.11 (1.04–1.18)	<0.001
Far vision subscale, per 5 points increase	1.20 (1.11–1.30)	1.06 (0.99–1.10)	<0.001

* Multivariate model from multinomial logistic regression using self-reported vision score 0 to 4 as the reference category.

† Wald χ^2 for global testing (type 3 analysis).

acuity and contrast sensitivity were most important in increasing the odds of being high functioning. This further supported that idea that visual acuity and contrast sensitivity are important determinants of self-rated vision status because they are important determinants of visual function. Visual function is, in turn, a driving determinant of self-rated vision status.

Also, we found that a number of visual function domains as represented by the ADVS subscales were significant determinants of self-rated vision status. Better function on the near and far vision ADVS subscales was associated significantly with increased odds of reporting good versus poor vision status. For our population, better functioning in the near vision subscale was most important for reporting better vision status.

These results demonstrated that different domains of visual function as represented by the ADVS subscales differ in their

degree of impact on self-rated vision status. Our results are consistent with previous studies that have demonstrated the importance of near vision to an elderly population. Poor near vision-related function was found to be associated consistently and independently with poorer quality of life and increased risk of being disabled in all areas of instrumental activities of daily living in an elderly population.³⁸ These findings may explain why near vision-related function may have been a particularly important determinant of self-rated vision status in our population. However, the impact of each domain of visual function on self-rated vision status likely is dependent on the activities that individuals favor as well as their expectations and lifetime experiences, and may be population-dependent (Fig. 2). In support of this point, another study in a different population found that distance vision-related function was

FIGURE 2. Proposed relationship between vision tests, visual function, and self-rated vision status.

more important than near vision-related function for overall quality of life.³⁹

In our study population, the night-driving subscale was not significantly associated with self-rated vision status. There are two possible reasons for this finding. One reason is that, for our study population, driving might not have been an important enough activity to affect our population's perception of their vision status. Indeed, nearly 20% of SEE participants never drove or did not drive during the year before the interview. Along those same lines, if poor vision did have a significant role in the self-restriction of driving, and by treating the driving-related items as missing data, we may underestimate the strength of the association between reporting better vision status and driving-related vision disability.

We also examined a number of demographic and nonvision health status characteristics, and their association with self-rated vision status. Interestingly, a decrease in MMSE status was associated independently with reporting worse vision status when examining the association between vision tests and self-rated vision status, and when examining the association between self-reported visual function and self-rated vision status. Previous studies have shown that the MMSE is a strong and independent predictor of activities of daily living (ADL) and instrumental activities of daily living (IADL).⁴⁰ We suggest that cognitive impairment, as represented by a decrease in MMSE status, globally and negatively affects everyday activity and function. This, in turn, might be interpreted and perceived by an individual as poor visual function and negatively affect self-rated vision status.

When examining the association between vision tests and self-rated vision status, we found that age was not an independent contributor to self-rated vision status. However, when examining the association between self-reported visual function and self-rated vision status, an increase in age increased the odds of reporting poor versus good vision. It is well established that performance on vision tests decreases with age, and we have reported that previously in the SEE population.¹⁷ Therefore, the independent contribution of age to self-rated vision status most likely was captured by the decrease in performance on vision tests seen with increasing age. However, age still was important in the model relating self-rated vision status and self-reported visual function, since vision tests were not included in that model.

We had reported previously that race and years of education were significantly correlated with discrepancies between self-rated vision and visual acuity.⁴¹ However, we note here that they were not correlated independently with self-rated vision status directly.

Limitations in our study include the potential for same-source bias when attempting to correlate self-report data as we did with the ADVS subscales and self-rated vision status. We see evidence of this in the associations observed with depression, for example. Depression was related to self-rated vision status in the model where vision tests were included, suggesting depression was related independently to self-rated vision status. However, in the model where the predictors were self-reported visual function (ADVS scale scores), depression was not related to self-rated vision status. This suggests that depressed persons tend to report their vision status and difficulty doing vision tasks similarly in a way that is not based on any correlation between the two measures, but rather is a function of the depression.

Also, we attempted to compare the impact of the different vision tests with self-rated vision status by comparing standard deviation units. The standard deviations depend on the distribution of the individual variables, and we recognize that such comparisons may not be equivalent clinically. Finally, near-vision acuity was not evaluated in the Salisbury Eye Study.

We would fully expect it to be independently and significantly correlated with self-rated vision status given the importance of near-vision function to self-rated vision status in our population.

Self-rated vision status is a multidimensional measure. In an elderly population of African American and Caucasian participants, a number of demographic and health status characteristics, vision tests, and different domains of visual function proved important determinants of self-rated vision status. However, the most important determinants of self-rated vision status in this population were visual acuity, contrast sensitivity, and near-vision visual function. This understanding may improve the ability of eye care providers to maximize self-rated vision status among their patients.

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