DEVELOPMENT OF A SCALE DESIGNED TO MEASURE FUNCTIONAL DISTANCE VISION LOSS USING AN INTERVIEW TECHNIQUE

Kenneth W. Haase and E. Earl Bryant
National Center for Health Statistics

Introduction

The National Health Interview Survey, in addition to providing health statistics on the population of the United States, carries out a research program designed to improve or to develop new survey methodologies. This paper presents the findings of one of the recent survey research activities conducted by the National Center for Health Statistics in cooperation with the American Foundation for the Blind and the National Society for the Prevention of Blindness. The purpose of this study was to develop and test three scales designed to measure functional vision loss by use of an interview technique. The scales consisted of a distance vision scale, a near vision scale, and a self-evaluation scale related to trouble seeing. This paper presents a preliminary assessment of the distance vision scale when used alone and when used in conjunction with the self-evaluation scale.

Methodology and Study Design

The basic methodology for the study involved the collection of data from two sources - an interview with clinic patients and an eye examination by ophthalmologists and clinic technicians which was performed immediately following the interview.

The universe consisted of patients 6 years of age and over who visited the general receiving wards of six eye clinics[1] during a four to six week period beginning in December 1972. Patients visiting the clinics for the first time were excluded.

Differential sampling rates were applied by strata and clinic such that the expected total sample size would be about the same for each clinic and for each of four visual acuity classes (better than 20/50, 20/50 to better than 20/100, 20/100 to better than 20/200, and 20/200 or worse). The sample consisted of 1,726 patients of whom 1,661 responded in the study.

Characteristics of the Sample Population

A most important qualification of the data presented in this paper is that they are applicable to a very select population, one which contains a large proportion of visually impaired, elderly, and poorly educated people. Numerous studies have indicated that the elderly and the less educated often have problems responding in interview surveys. Therefore, these factors should be considered when interpreting the findings of this study.

Development and Analysis of the Distance Scale

In development of the distance scale, major consideration was given to the types of questions that would identify persons with functional distance vision loss and could discriminate between various degrees of that loss.

The scale consisted of the five questions shown in Figure A. The questions are ordered in the form of a Guttman Scale[2]; that is, the first four questions are ordered so that when the first negative answer is obtained, all following answers are expected to be negative. The Guttman technique permits the use of several approaches in evaluating the merits of this instrument. These include the assessment of face validity, construct validity and content validity.

Figure A. The distance scale questions used in the vision study.

(1) (When wearing glasses) can you see well enough to recognize a friend if you get close to his face?

(2) (When wearing glasses) can you see well enough to recognize a friend who is an arm's length away?

(3) (When wearing glasses) can you see well enough to recognize a friend across a room?

(4) (When wearing glasses) can you see well enough to recognize a friend across a street?

(5) Do you have any problems seeing distant objects?

Face validity, while somewhat subjective, should be the first criterion applied to any survey technique. The questions applied to this scale were "Do these questions make sense in classifying functional vision loss?" and "Do they form a hierarchy of severity?" Since the reference point, "recognizing a friend", was kept constant and the conceptual stimulus was decreased by moving the friend further from the respondent, the scale has the appearance of logically classifying various degrees of functional vision loss.

In terms of construct validity the Guttman approach permits a measurement of internal consistency within the scale itself. Each sample person was asked all of the first four questions of the scale regardless of the previous answer.

For example, if a person reported he could not see a friend across a room he was still asked whether he could see a person across a street. Therefore, it was possible to determine scaleability by analyzing the consistency of the responses. Of the 1,661 persons who answered these questions only about 1 percent responded inconsistently. Based on experience from other studies involving scaleability these findings indicate a very high degree of consistency.

The final measurement of validity is content validity; that is, whether the scale actually measures what it is intended to measure. However, before looking at the findings which compare interview data with clinical measurements, we should give some attention to the differences between these two measuring techniques. How a person perceives he can function is related to a number of factors of which his physical capability is only part. These scales are psychological measurements which will be influenced by actual visual acuity measurements. Also they will be related to the patient's own subjective evaluation of the severity of his visual impairment and the degree of effort he puts forth in overcoming it. In addition the environment in which the person generally functions may be quite different from the clinic environment in which the examination was performed. Therefore, both measurements, assuming that they adequately represent the phenomenon of interest, are important statistics in their own right. Since the two measurements are different we do not expect a perfect association, but since they both measure the same phenomenon from a different perspective, we should expect to find a statistical relationship. In this paper we have used Pearson's phi coefficient[3] as an indicator of the degree of association between the two measurements.

If one accepts the hypothesis that persons with similar visual acuity measures can have different perceptions of their degree of functional vision loss, how then does one interpret a statistical correlation between the two measures. To some degree it must be a value judgement. But, comparisons must also be made among the different subgroups, identified by this scale to determine if the distributions of these subgroups by visual acuity are different and if these differences are in the directions expected. Further, the analysis should also include an analysis of the outliers. While we might accept the fact that a person's perception of his degree of functional vision loss can vary considerably with the measurement of his visual acuity, we could evaluate the scale in terms of the apparent inconsistencies. For example, a person who is classified by the scale as having a severe vision loss, should not be expected to have a normal or near normal visual acuity. These outliers will be referred to in this paper as potential false positives and potential false negatives.

Table 1 presents the distribution of the sample according to visual acuity by degree of functional distance vision loss as measured by the distance scale. The clinical measures in this table as in all the following tables are based on measures of visual acuity in the best eye with the sample persons using the type of corrective lens that he usually uses.

Table 1. Number and Percent Distribution of Sample Persons According to Visual Acuity (present corrections in best eye) by Distance Vision Scale.

VISUAL ACUITY (present correction in best eye)	Total		DISTANCE VISION SCALE				
			Cannot recognize a friend at arm's length away	Can recognize a friend at arm's length but not across a room	Can recognize a friend across a room but not across a street	Can recognize a friend across a street	
	Persons[1]	Percent				Some problem seeing distant objects	No problem seeing distant objects
			(Percent Distribution)				
TOTAL	1576	100.0	12.9	16.0	19.8	14.7	36.6
20/400 or worse	219	100.0	53.0	26.5	11.4	3.7	5.5
20/200 to better than 20/400	178	100.0	15.7	36.5	28.1	9.6	10.1
20/70 to better than 20/200	225	100.0	9.3	23.6	32.0	15.1	20.0
20/40 to better than 20/70	339	100.0	7.9	14.8	25.4	16.8	35.1
20/25 to better than 20/40	312	100.0	2.6	7.1	16.4	19.9	54.2
Better than 20/25	303	100.0	1.0	1.3	9.2	17.8	70.6

[1]Excluded from this table are 28 persons for whom the distance scale measure was unknown and 57 for whom visual acuity was unknown.

The value of phi for the distribution for the sample in this table is .35. This somewhat weak association (the value of phi can range from 0 to 1) is partially due to the difference in the measures as discussed above. Also, it may be influenced by how the data are grouped. Since we have no prior evidence to indicate what scale score should be expected for a given visual acuity group, determining adequate cutting points is somewhat difficult. It can be observed, however, that for the extreme visual acuity groups, i.e. 20/400 or worse and the groups better than 20/40, there is a tendency to cluster around the scale scores that might be expected for these groups. However, for the middle visual acuity groups the distribution shows a much wider variation with no salient modal measure.

In analyzing the outliers, that is, those observations that appears to be inconsistent, we found that for the 20/400 or worse group an accumulative total of 9.2 percent reported that they could see well enough to recognize a friend across a street. Ten percent of persons with 20/200 to better than 20/400 vision and 20 percent of persons with 20/70 to better than 20/200 vision reported having no trouble seeing. For those persons with good or normal vision (better than 20/25), an accumulative total of 11.5 percent reported they could not see a friend across a street.

Table 2 shows how the sample is distributed by visual acuity measurement for each of the scale categories. Of the 203 persons who reported that they could not see well enough to recognize a friend an arm's length away 57 percent had a visual acuity of 20/400 or worse, while 1.5 percent had normal vision (better than 20/25), and an accumulative total of 5.4 percent had a visual acuity of better than 20/40. At the other end of the scale, of the 577 persons who reported that they had no problem seeing distant objects, an accumulative total of 5.2 percent had a visual acuity of 20/200 or worse, which is the cutting point for determining legal blindness.[4] As expected the bulk of those persons reporting no problems are clustered in the better visual acuity groups.

The vision questionnaire included a set of questions designed to obtain the respondent's self-evaluation of his vision in each eye separately (see Figure B).

Figure B. The self-evaluation scale questions used in the vision study.

(1) (When wearing glasses) how much trouble do you have seeing with your <u>left</u> eye--a lot of trouble, a little trouble, or no trouble at all?

(2) (When wearing glasses) how much trouble do you have seeing with your <u>right</u> eye--a lot of trouble, a little trouble, or no trouble at all?

Table 2. Number and Percent Distribution of Sample Persons According to the Distance Vision Scale by Visual Acuity (present corrections in best eye).

VISUAL ACUITY (present correction in best eye)	TOTAL	DISTANCE VISION SCALE				
		Cannot recognize a friend at arm's length away	Can recognize a friend at arm's length but not across a room	Can recognize a friend across a room but not across a street	Can recognize a friend across a street: Some problem seeing distant objects	Can recognize a friend across a street: No problem seeing distant objects
Total Number of Persons[1]	1576	203	252	312	232	577
	(Percent Distribution)					
Total Percent	100.0	100.0	100.0	100.0	100.0	100.0
20/400 or worse	13.9	57.1	23.0	8.0	3.5	2.1
20/200 to better than 20/400	11.3	13.8	25.8	16.0	7.3	3.1
20/70 to better than 20/200	14.3	10.3	21.0	23.1	14.7	7.8
20/40 to better than 20/70	21.5	13.3	19.8	27.6	24.6	20.6
20/25 to better than 20/40	19.8	3.9	8.7	16.4	26.7	29.3
Better than 20/25	19.2	1.5	1.6	9.0	23.3	37.1

[1]Excluded from this table are 28 persons for whom the distance scale measured was unknown and 57 patients for whom visual acuity was unknown.

These questions provide a four point scale of the respondents self assessment of his ability to see with each eye ranging from blind to no trouble seeing.

Although the respondents were instructed to respond to the distance scale in relation to their total vision, it is possible to hypothesize that some persons with an impairment in only one eye might respond in terms of that eye rather than their overall vision. In a somewhat similar study designed to develop a hearing scale[5] a relatively large segment of the false positives resulted from persons with little or no hearing loss in one ear who were responding in terms of their impaired ear.

To test whether this phenomenon was also present in the distance vision scale we combined the responses obtained for each person's self-evaluation for each eye to establish two categories: (1) those persons reporting at least a little trouble seeing in both eyes and; (2) those persons reporting they have no trouble seeing in at least one eye. Although there will be some reduction in the field of vision, a person who has severe vision loss in one eye but normal vision in the other should be able to see well enough to recognize a friend. Therefore, persons reporting no trouble seeing in one eye are treated as a separate group and only those persons with some trouble seeing in both eyes are classified according to their response to the distance scale. Table 3 shows how the sample is distributed by visual acuity according to this joint classification.

The phi coefficient for Table 3 is .36 which is similar to the association observed in the first set of tables. However, there is a shift in the potential outliers. Using the distance scale by itself we found that all but 9.2 percent of persons with 20/400 or worse reported that they could not see a friend across a street. With this joint classification 17.6 percent of this severe visual acuity group are potential false negatives, of which the bulk fall into the category of one or both eyes good. A similar increase of potential false negatives is also observed in those groups with 20/70 or worse. It would appear that some proportion of those persons who report that they have no trouble seeing in one eye do in fact have severe vision loss in their better eye. It is possible that because of the subjective nature of the self-evaluation scale, some respondents with extreme loss in one eye and the other eye impaired, but to a lesser degree, may overrate their better

Table 3. Number and Percent Distribution of Sample Persons According to Visual Acuity (present correction) by Self-Evaluation and Distance Scale Measures.

VISUAL ACUITY (present correction in best eye)	SELF-EVALUATION AND DISTANCE VISION SCALE							
	Total		Trouble Seeing in Both Eyes					
			Cannot recognize a friend at arm's length away	Can recognize a friend at arm's length but not across a room	Can recognize a friend across a room but not across a street	Can recognize a friend across a street		No trouble seeing in one or both eyes
	Persons[1]	Percent				Some problem seeing distant objects	No problem seeing distant objects	
			(Percent Distribution)					
TOTAL	1526	100.0	11.7	13.2	13.4	7.7	9.3	44.8
20/400 or worse	215	100.0	50.7	22.8	8.8	2.3	1.9	13.5
20/200 to better than 20/400	168	100.0	15.5	32.7	24.4	7.1	5.4	14.9
20/70 to better than 20/200	213	100.0	9.4	20.7	23.5	9.9	8.0	28.6
20/40 to better than 20/70	324	100.0	5.9	11.7	15.4	10.8	12.4	43.8
20/25 to better than 20/40	306	100.0	1.3	4.6	9.5	11.1	13.4	60.1
Better than 20/25	300	100.0	.3	.3	5.0	3.3	10.3	80.7

[1]Excluded from this table are 135 persons for whom the self-evaluation scale, distance scale or visual acuity measures were unknown.

eye because this judgement is made relative to their worse eye. Although we plan to test this hypothesis in future analysis, at the present time we can only speculate on the reasons for these apparent inconsistencies.

While combining the self-evaluation scale with the distance scale increases the potential false negatives, it does appear to decrease the proportion of potential false positives. Using the distance scale alone we saw that an accumulative total of 11.5 percent of the persons with normal vision reported that they were unable to recognize a friend across a street. By excluding those persons who reported having no trouble seeing in one or both eyes the proportion of potential false positives is reduced by 5.6 percentage points. Therefore, if we assess the distance scale as a screening device, the inclusion of the self rating scale appears to decrease its sensitivity in that it increases the proportion of potential false negatives but increases its specificity in that it decreases the proportion of potential false positives. Since in the general population only a small proportion of persons will have a vision problem, the false positives will cause much more distortion of an estimate derived from these procedures than would be caused by false negatives. In fact, if the 5.6 percent potential false positives are actually false positives, and if the same proportion were present in a national survey, the estimate for vision impairment would be doubled. However, there are reasons to assume that the proportion of false positives within a general population would not be of this magnitude. First, some of these potential false positives may be caused by other vision defects such as restricted field vision which may not be reflected in the visual acuity measurement. Although information on other vision defects is available to us, we have not had time to analyze it. Secondly, since all sample persons when interviewed were visiting a clinic for some reason related to their eyes or vision there might have been a tendency for some proportion of the study population to exaggerate their vision problem.

Table 4 presents the number of persons classified by the joint distance and self-evaluation scale distributed according to their visual acuity measures. By excluding the persons who report no trouble seeing in one or both eyes the proportion of persons with normal acuity is decreased in all of the distance scale groups. The proportion of persons with a visual acuity of 20/70 or worse is increased in all the scale response groups including those who report no problem seeing by this joint classification.

Table 4. Number and Percent Distribution of Sample Persons According to Self-Evaluation and Distance Scale Measures by Visual Acuity (present correction).

VISUAL ACUITY (present correction in best eye)	SELF-EVALUATION AND DISTANCE VISION SCALE						
	Total	Some Trouble Seeing in Both Eyes					No trouble seeing in one or both eyes
		Cannot recognize a friend at arm's length away	Can recognize a friend at arm's length but not across a room	Can recognize a friend across a room but not across a street	Can recognize a friend across a street: Some problem seeing distant objects	Can recognize a friend across a street: No problem seeing distant objects	
Total number of persons[1]	1526	179	201	204	117	142	683
Total Percent	100.0	100.0	100.0	100.0	100.0	100.0	100.0
20/400 or worse	14.1	60.9	24.4	9.3	4.3	2.8	4.3
20/200 to better than 20/400	11.0	14.5	27.4	20.1	10.3	6.3	3.7
20/70 to better than 20/200	14.1	11.2	21.9	24.5	18.0	12.0	8.9
20/40 to better than 20/70	21.1	10.6	18.9	24.5	29.9	28.2	20.8
20/25 to better than 20/40	20.1	2.2	7.0	14.2	29.1	28.9	26.9
Better than 20/25	19.6	.6	.5	7.4	8.6	21.8	35.4

[1]Excluded from this table are 135 persons for whom self-evaluation scale, distance scale or visual acuity measures were unknown.

In summary, the analysis of responses to the distance scale indicates a high degree of internal consistency, which provides evidence that the order and nature of this set of questions have ordinal characteristics.

When comparing the responses from the distance scale with visual acuity measures, we found a positive but relatively weak statistical association. While combining the distance and self-evaluation scale increased the proportion of potential false negatives, it decreased the proportion of potential false positives, which is assumed to create a more important measurement problem. Although there remains a number of unexplained inconsistencies in these findings, some of which might be explained in further analysis of these data, we are generally encouraged by the distance scale's ability to classify populations according to perceived functional vision loss. Therefore, we are presently planning to incorporate this scale into the next cycle of the National Health Examination Survey to test it on the national population. The methodology will be similar to that employed in this study but the findings can be inferred to the general population.

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[1]The clinics participating in this study were (1) Massachusetts Eye Infirmary, Boston, Mass.; (2) New York Eye and Ear Infirmary, New York, N.Y.; (3) University of Minnesota Eye Clinic, Minneapolis, Minn.; (4) Washington University Medical Center, St. Louis, Mos.; (5) Wills Eye Hospital, Philadelphia, Pa.; and (6) Wilmer Clinic, Baltimore, Md.

[2]Guttman, L., "The Cornell Technique for Scale and Intensity Analysis," Educational and Psychological Measurements, 1957, 7:247-279.

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[4]In clinical terms, legal blindness is usually defined as central visual acuity of 20/200 or less in the better eye, with correcting glasses; or central visual acuity of more than 20/200 if there is a defect in which the peripheral field has contracted to such an extent that the widest diameter of vision subtends an angular distance no greater than 20 degrees.

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