# Vision screening of illiterate populations

B. THYLEFORS [1]

*To assess the amount of reduced vision in a population is an important public health matter, especially in areas where blinding diseases are endemic. Testing visual acuity is, however, a complex problem when a major part of the population is illiterate. The best-known test of vision is the E-test, but this produces the problem of untestability in illiterate populations.*

*The introduction of the Sjögren hand-test as an alternative to the E-test for vision screening of unselected illiterate populations in West Africa resulted in a highly significant reduction of untestability. For certain vision levels it is possible to correlate the results of the hand-test directly with those of the E-test. The hand-test is less well defined than the E-test, but has important advantages for the purpose of vision screening of illiterate populations.*

The well-known E-test of Snellen has been widely used in studies dealing with visual acuity. However, this test may be difficult for illiterate populations to understand. Untestability has been defined by Lippmann (*5*) as " inability to learn the test and to give reliable responses ". The patient may either be completely unable to understand and learn the test procedure, or may give unreliable responses because of poor understanding and cooperation. Untestability thus implies that much information about the visual acuity of the patient is lost or of doubtful reliability. Several authors (*1*, *9*, *10*) have reported untestability when using the E-chart, but the extent of the problem when dealing with unselected, illiterate populations has not been investigated. Experience from a number of field surveys conducted by the author in West Africa showed that the E-chart gave a high untestability rate.

In order to reduce the loss of data if possible, the hand-test of Sjögren (*11*) was introduced as an alternative to the E-test for vision screening. The hand-test is considered by several authors to be easily understood (*2*, *3*, *7*) and has been used for vision screening of children (*2*, *8*). To compare the results obtained with the two tests, an investigation of correlation and reliability was carried out.

## MATERIALS AND METHODS

### *Tests used*

An E-chart (decimal scale, distance 5 m) was used to test the visual acuity of 929 unselected persons. A large metallic " E " was held in front of the person to be tested, with explanations, opportunity for practice, and sometimes also group training to improve cooperation. Each eye was tested separately without correction with glasses. The levels of visual acuity examined were: 1.0 (6/6 or 5/5); 0.7 (6/9 approximately or 5/7.5); 0.3 (6/18 approximately or 5/15) and 0.1 (6/60 or 5/50). The test was always performed under good daylight conditions and the test was presented as uniformly as possible, with a maximum of 10 min spent on each case. The test procedure was conducted by one ophthalmic nurse or two trained assistants under the direct supervision of the ophthalmologist, who also participated in testing difficult cases.

All the examinations in this study were conducted in small villages situated in northern Ivory Coast, the Northern and Upper Regions of Ghana, and Upper Volta.

The hand-test was used in a total of 1163 persons. The 19 cm square test cards, each depicting a hand in silhouette (an example is shown in Fig. 1), were supplied [a] in a standard series comprising visual

[1] WHO Ophthalmologist, Onchocerciasis Control Programme in the Volta River Basin area, Ouagadougou, Upper Volta.

[a] Address of manufacturer: AB Stille-Werner, Bondegat. 21, 102 61 Stockholm, Sweden.

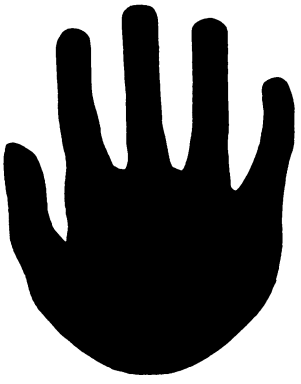

Fig. 1. Actual size of hand corresponding to visual acuity level 5/15 with a test distance of 5 m.

acuity levels in a metric scale from 5/50 to 5/3 with a test distance of 5 m. The test card depicting the largest hand (5/50) was first presented to the patient and, after explanations and training, the test was performed under the same conditions as for the E-test, corresponding visual acuity levels being examined.

In order to obtain identical test conditions for the E-test and hand-test, a set of separate E-cards, equal to an E-chart, 5 m, was used. The cards bore a single E in different sizes and were identical in size and quality to the hand-cards. Visual acuity testing was conducted with these E-cards in a total of 1098 persons, the manner of presentation, training, test distance, and other conditions being the same as for the hand-test.

Finally, a simple screening procedure was designed to detect cases of visual impairment. The hand-test was used as indicated above, but only binocular vision at the level of 0.3 (6/18 or 5/15) was tested. Only cases that failed to pass this threshold were then tested in greater detail. This test was conducted in 5642 unselected persons.

*Correlation between the E-test and the hand-test*

The results of the hand-test were correlated with those of the E-test by performing both tests in the same patient, with identical presentation of the test, training, test distance, and visual acuity levels examined. Only the E-test cards were used in the E-test. Since the order of the tests may be of importance, the E-test was conducted first in half of the cases tested, and the hand-test was given first in the other half.

To evaluate the reliability of the tests, the E-chart was used in an unselected population of 277 persons (554 eyes examined), the E-test cards in 237 persons (468 eyes), and the hand-test in 249 persons (495 eyes). A patient tested in one of these three ways was retested the following day in the same way.

To meet the requirements for a certain level of visual acuity, the patient had to read correctly: 4 consecutive positions, 5 out of 6 showings, or 6 out of 8 showings, as laid down by Borg & Sundmark (*2*) and Nordlöw (*6*).

## RESULTS

The populations examined by the various methods of testing visual acuity, and the corresponding untestability rates by age and sex, are shown in Table 1. The untestability rates show a highly significant difference ($P < 0.001$) between the total results with the E-chart and with the E-test cards, and also between both versions of the E-test and the hand-test. The difference is the most pronounced in the 5–9-year age group, but is also evident in females aged more than 30 years. The two versions of the hand-test show no significant difference as regards untestability.

The results of the comparison of the E-test cards and hand-test are shown in Tables 2 and 3. A preliminary test was performed in a pilot village in an unselected population of 195 persons, the hand-test being used first (Table 2). The original levels of that test, as defined by Sjögren (*11*), are such as to render it easier than the E-test at corresponding levels.

The hand-test scale was later modified so that the next smaller test-type in the standard series was used to correspond to the same E-test level as before. The results are shown in Table 3, which refers to the whole population of two villages plus all persons in two other villages who had a visual acuity worse than 1.0 or 5/4. In total, 488 persons (962 eyes) were examined by both the E-test and the hand-test in the order mentioned above.

The correlation shown in Table 3, which included a high proportion of cases with visual impairment, was very good, but there was a slight tendency for the 5/4 test-type to be more easily seen than the 1.0 E-level. However, the hand-card designated as 5/3 was evidently more difficult to discern than the 1.0 E-level, and was therefore rejected.

The total reliability rates of the E-chart, E-test cards, and hand-test, calculated from the number of

Table 1. Numbers of people examined and untestability rates (%) according to age and sex

| Age (years) | | E-test chart | | E-test cards | | Hand-test | | Hand-test binocular screening | |
|---|---|---|---|---|---|---|---|---|---|
| | | M | F | M | F | M | F | M | F |
| 5–9 | examined | 84 | 88 | 109 | 127 | 111 | 96 | 539 | 525 |
| | untestable % | 69.1 | 85.2 | 50.5 | 44.1 | 22.5 | 32.3 | 21.5 | 21.1 |
| 10–14 | examined | 102 | 85 | 120 | 93 | 115 | 88 | 599 | 449 |
| | untestable % | 7.8 | 16.5 | 2.5 | 4.3 | 0.9 | 1.1 | 1.5 | 2.9 |
| 15–29 | examined | 80 | 113 | 116 | 122 | 110 | 176 | 621 | 823 |
| | untestable % | 0.0 | 7.1 | 0.0 | 4.1 | 0.0 | 1.1 | 0.8 | 1.7 |
| 30–49 | examined | 138 | 138 | 125 | 150 | 144 | 161 | 655 | 727 |
| | untestable % | 2.2 | 13.0 | 1.6 | 11.3 | 0.7 | 3.1 | 0.9 | 3.3 |
| 50 + | examined | 58 | 43 | 63 | 73 | 89 | 73 | 358 | 346 |
| | untestable % | 3.5 | 20.9 | 1.6 | 20.6 | 1.1 | 2.7 | 1.1 | 4.3 |
| Sub-total | examined | 462 | 467 | 533 | 565 | 569 | 594 | 2772 | 2870 |
| | untestable % [a] | 14.7 | 21.8 | 10.1 | 13.3 | 4.5 | 6.1 | 4.6 | 5.2 |
| Total | examined | 929 | | 1098 | | 1163 | | 5642 | |
| | untestable % [a] | 17.7 | | 11.2 | | 5.1 | | 4.7 | |

[a] Rates adjusted for age and sex.

Table 2. Correlation [a] between E-test and hand-test for four levels of visual acuity. Contingency table [b] with original metric scale of hand-test (Sjögren)

| Hand-test levels | E-test levels | | | | |
|---|---|---|---|---|---|
| | 1.0 | 0.7 | 0.3 | 0.1 | |
| 5/5 | 326 | 31 | 0 | 0 | 357 |
| 5/7.5 | 1 | 4 | 11 | 0 | 16 |
| 5/15 | 0 | 1 | 2 | 3 | 6 |
| 5/50 | 0 | 0 | 0 | 4 | 4 |
| | 327 | 36 | 13 | 7 | 383 |

[a] Correlation coefficient (Kendall's $\tau$) = 0.66.
[b] Each eye examined was correlated separately.

Table 3. Correlation [a] between E-test and hand-test for four levels of visual acuity. Contingency table [b] with modified metric scale of hand-test

| Hand-test levels | E-test levels | | | | |
|---|---|---|---|---|---|
| | 1.0 | 0.7 | 0.3 | 0.1 | |
| 5/4 | 716 | 8 | 0 | 0 | 724 |
| 5/5 | 4 | 81 | 0 | 0 | 85 |
| 5/10 | 0 | 0 | 117 | 0 | 117 |
| 5/30 | 0 | 0 | 0 | 36 | 36 |
| | 720 | 89 | 117 | 36 | 962 |

[a] Correlation coefficient (Kendall's $\tau$) = 0.97.
[b] Each eye examined was correlated separately.

examined eyes with an identical visual acuity level on both test occasions, were 83.4%, 84.2%, and 92.5%, respectively. The reliability of the hand-test was significantly greater ($P < 0.001$) than that of the E-test. However, persons with a vision of 1.0 (5/4) at the first test are likely to show an identical vision level at the second test, since the result in itself presupposes reliability. It is more relevant, therefore, to compare the reliability for vision levels worse than 1.0 (5/4), in order to reveal cases of relative untestability because of unreliable responses. Such comparison shows a reliability rate of only 34.8% for the

E-chart and 36.1% for the E-test cards, but 61.7% for the hand-test, which is significantly ($P < 0.001$) in favour of the hand-test.

## DISCUSSION

The E-test has been much used in children, and untestability is generally considered to be low from the age of 4–6 years, as reported by several authors (*5*, *6*, *7*), although important variations were found by Sawitz et al. (*10*). Relatively high rates of untestability were found in the present study, especially when a visual chart was used. In Cameroon, Anderson & Fuglsang (*1*) found about 5% total untestability with the E-chart, but this lower rate may reflect differences in the population examined and reliability was not investigated. The pattern of untestability according to age and sex in the present study was the same for all the tests, most of the untestable cases being found in children less than 10 years old and in women in the older age groups.

The importance of showing single test-types in order to improve the degree of cooperation has been emphasized (*3*, *4*, *5*, *7*), and this was also the experience in the present study. The visual chart has the disadvantage of being difficult to understand as well as providing very few test-types for the 6/60 level of visual acuity. It cannot be considered as adequate to diagnose visual impairment after only 2 or 3 positions have been tested with it, and fingercounting in such cases is less accurate and will not reveal untestability. Patients without visual impairment may, quite by chance, make a correct reading of the first line of the chart, but they may not be able to cooperate further. Thus, there is a risk of recording a severe degree of visual impairment when, in fact, the patient sees well but is untestable. This is reflected in the significantly lower reliability of the E-test, in comparison with the hand-test. As observed by Borg & Sundmark (*2*), there was a tendency to improve the visual acuity results with training, especially in the risk group of untestability, i.e., children and elderly women.

The advantage of group training has been underlined by J. P. Ganley, unpublished observations, 1975. Undoubtedly it improves cooperation, but its success is limited, since small children and shy women are usually difficult to involve in the training. Group training also requires a very good, active local interpreter/leader in the village.

The important role that psychological factors play in testing visual acuity has been emphasized (*2*, *3*, *5*, *6*). Such testing is difficult in densely populated villages. Cultural deprivation, isolation, and a low social level have also been pointed out (*5*, *7*, *9*) as exerting a negative influence. It is difficult to evaluate these factors in African populations, however. Thus, in the present study, the villages examined were situated in remote areas and had a very low socioeconomic level.

The hand-test was introduced by Sjögren in 1939 in a version based on the principle of Snellen. The size of the fingers and their intervening spaces were calculated so that the angle of vision was one minute when the card was seen at a certain distance, which was marked on the back of the card (*11*). However, not only the fingers but also the shape in general are important for this type of test, and unfortunately the oval outline of a hand may assist in locating the direction of the fingers, as was observed by Borg & Sundmark (*2*). The original metric scale of Sjögren therefore does not correspond exactly to the E-test levels examined in the present study. Reduction of the hand-test type size by one metric step allows very good correlation with the E-test, as tested for four levels of visual acuity. Although decimal and metric scales and other test conditions were not investigated, the hand-test was shown to be of value for screening illiterate populations, and it showed a correlation sufficient to enable vision levels to be categorized with a high degree of accuracy.

## RÉSUMÉ

### EXAMENS DE LA VUE DANS DES POPULATIONS ILLETTRÉES

L'épreuve d'acuité visuelle de Snellen (optotypes en forme de E) a largement été utilisée dans les enquêtes de terrain mais, étant donné la difficulté chez les illettrés de comprendre cette épreuve, celle-ci s'est révélée inapplicable pour une forte proportion de sujets.

En Afrique occidentale, une population non sélectionnée et en grande partie illettrée de 3190 individus a été soumise à différentes épreuves de la vue: optotypes en forme de E (tableau), optotypes en forme de E (cartons) et épreuve de la main de Sjögren. Il a été constaté que

ces trois épreuves étaient inapplicables respectivement dans 17,7%, 11,2% et 5,1% des cas. Le recours à l'épreuve de la main pour l'examen simple de la vision binoculaire dans une autre population non sélectionnée de 5642 individus a révélé un taux d'inapplicabilité de 4,7%. L'épreuve de la main était aussi nettement plus fiable que celle des optotypes en forme de E, notamment chez les personnes à vision réduite.

Dans la présente enquête, le tableau épidémiologique de l'inapplicabilité de l'épreuve était identique pour les trois épreuves. Cette inapplicabilité a été observée principalement chez des enfants de moins de 10 ans et chez des femmes, surtout des femmes âgées. Le taux d'inapplicabilité est influencé par un certain nombre de facteurs. On a obtenu une meilleure coopération des intéressés en n'utilisant qu'un seul type d'épreuve et en recourant à des explications de groupe, mais des facteurs psychologiques tels que les conditions de l'épreuve, la carence culturelle et le niveau social doivent également être pris en considération.

Outre qu'elle est difficile à comprendre, l'épreuve des optotypes en forme de E (tableau) n'offre pas une variété de positions suffisante pour diagnostiquer correctement les troubles graves de la vue. Au moins quatre positions consécutives correctes, ou une probabilité équivalente, seraient nécessaires pour définir un niveau donné d'acuité visuelle. Si l'on a recours à cette épreuve, on risque de diagnostiquer une diminution sérieuse de la vision chez des sujets auxquels le test est inapplicable.

L'épreuve de la main et celle des optotypes en forme de E sont toutes deux fondées sur le principe de Snellen, bien que la forme de la main soit moins nettement définie que la forme géométrique de la lettre « E ». Le contour ovale de la main peut aider à localiser les doigts, de sorte que dans des conditions identiques la main est plus facile à discerner que la lettre E. Toutefois, en diminuant la dimension de la main d'une gradation dans la série de cartes disponibles, on a pu pour certains niveaux de vision obtenir une corrélation satisfaisante avec l'épreuve des optotypes en forme de E. L'épreuve de la main peut donc être utilisée en lieu et place de celle de la lettre E dans les examens de la vue chez les illettrés, et en outre son grand avantage est que le taux d'inapplicabilité est sensiblement plus faible.

## REFERENCES


1. ANDERSON, J. ET AL. Studies on onchocerciasis in the United Cameroon Republic. Comparison of populations with and without *Onchocerca volvulus*. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, **68** (3): 190-208 (1974).
2. BORG, G. & SUNDMARK, E. A comparative study of visual acuity tests for children. *Acta ophthalmologica*, **45**: 105-113 (1967).
3. FFOOKS, O. Vision test for children. *British journal of ophthalmology*, **49**: 312 (1965).
4. KOHLER, L. & STIGMAR, G. Vision screening of four-year-old children. *Acta paediatrica scandinavica*, **62**: 17-27 (1973).
5. LIPPMANN, O. Vision screening of young children. *American journal of public health*, **61** (8): 1587-1601 (1971).
6. NORDLOW, W. & JOACHIMSSON, S. A. screening test for visual acuity in four year old children. *Acta ophthalmologica*, **40**: 453-462 (1962).
7. OLIVER, M. & NAWRATZKI, I. Screening of preschool children for ocular anomalies. *British journal of ophthalmology*, **55**: 462-466 (1971).
8. PRESS, E. & AUSTIN, C. Screening of preschool children for amblyopia. *Journal of the American Medical Association*, **204** (9): 767-770 (1968).
9. SARKIES, J. W. R. Ocular onchocerciasis. *British journal of ophthalmology*, **36**: 83 (1952).
10. SAWITZ, R. A. ET AL. Testability of pre-school children for vision screening. *Journal of pediatric ophthalmology*, **1**: 15-34 (1964).
11. SJÖGREN, H. A new series of test-cards for determining visual acuity in children. *Acta ophthalmologica*, **17**: 67-68 (1939).