Causes of low vision in Sudan: a study among the attendees of blind centres in Khartoum

Atif Babiker Mohamed Ali¹, Elhadi Ahmed Elsheikh², Mohamed Elhassan Ali Elawad¹

¹Faculty of Optometry, Alneelain Universiy, Khartoum, Sudan
²Ophthalmology department, Faculty of Medicine, University of Khartoum, Sudan

Correspondence to: Dr. Atif Babikir, Faculty of optometry; University of Alneelain, P.O 12702, Khartoum, Sudan. E-mail: atfbm@yahoo.com. Tel: +249911371556.

Abstract
Aims: This study primarily aimed to provide demographic information about the low vision in the blind center at Khartoum state. The objectives were to indicate the main causes of low vision and to show the effect of these causes on the visual functions and mobility among a sample group. Methods: Clinical investigations were performed for visually impaired sample (171 subjects) from Sudan National Association of the Blind and Elnur Institute. Functional tests included; visual acuity (log MAR), contrast sensitivity (Pelli-Robson), colour vision (colour vision test made easy), confrontation and Amsler tests; structural inspection of anterior eye and interior eye; refraction; assessment of low vision devices; and observation of mobility. Results: The results revealed that 39.7% of subjects in blind centers had low vision which can be improved with proper low vision aids. Significant deficiencies were found for all visual functions. The trend of causes is similar to that found in most developing countries. Statistically all causes had similar effect on visual functions. Mobility had provided good indicator differentiating functional vision from a non-useful residual vision in the blinds. Conclusions: There is a great need for the ophthalmologists and optometrists to be aware about the causes, functional effects of low vision in the population, and the possibility of improving vision with the help of low vision devices to a satisfactory level.

Keywords: Low vision; Visual functions; Refraction; Low vision devices; Causes; Mobility.

INTRODUCTION
The term low vision describes vision disorders that can not be corrected with medical treatment, surgical interference, or conventional eye glasses or contact lenses. Hence, low vision refers to a wide range of vision reduction between normal vision and no light perception. The visual loss can be central (reduced visual acuity) or peripheral (reduced field). The common aggravating problems are decreased night vision, reduced contrast sensitivity, reduced colour perception, and glare. The available treatment of low vision involves the provision of special optical devices and adaptive devices, combined with rehabilitation services to help individuals maximize their remaining vision.

On the other side, the relationship between low vision and blindness has only recently been well and clearly understood. The vast majorities of people in the world who are considered blind (by some legal definition) in fact have low vision, and are in principle capable of and wish to use their vision for tasks. Blindness and low vision if not...
considered as important health problem, they will have profound effects on the quality of life for many people. They affect normal development and education of children, they inhibit mobility and economic well-being of the individuals affected. In addition there is a huge amount of emotional and social stress the individual might experienced as a result of being blind ².

Recently, great efforts have been made to promote prevention and to combat the most common causes of blindness through the public health approaches and international organizations. The number of blind people from infectious diseases and malnutrition are likely to be reduced. Nevertheless, the number of people presenting with low vision tend to increase because most of the major causes of low vision are congenital, degenerative, and age-related conditions. It is estimated that 0.85% of the world's population has a corrected visual acuity in the better eye of less than 3/60 and approximately 80% of visually impaired persons live in developing countries ³.

A person with low vision is one who has impairment of visual functioning even after treatment/or standard refractive correction, and has a visual acuity of less than 6/18 to light perception, or a visual field less than 10 degrees from the point of fixation but who uses, or is potentially able to use vision for the planning and/or execution of a task ⁴.

Sudan is the largest country in Africa with a population more than 35 million. Difficulty of transport in most parts and regional conflicts make the medical and rehabilitation services almost painstaking task. Therefore, it is noticed that most of hospitals, private clinics, and specialists are concentrated in Khartoum, where approximately 70% of eye care is found in Khartoum. From the unpublished data collected by different investigators and regional surveys, the prevalence of blindness was estimated to be 1.5% in Sudan. Cataract is believed to be responsible for 60% of blindness and other causes including trachoma, onchocerciasis, and glaucoma⁵-⁷.

Rehabilitation services for the visually impaired persons in Sudan are actually very weak and limited. In the whole country there is one teaching institute “Elkur Institute” at Khartoum North established in 1960 as special primary school for blind children. It covers only the basic stage using simple tactile and auditory systems in teaching. The secondary stage should be attended in ordinary schools by using the hearing sense only. In 1970, the Sudan National Association of the Blind (SNAB) was founded in Khartoum North. The aim of SNAB is to gather blind people for educational, vocational, recreational, and occupational integration. However, few blind people in the whole country receive the rehabilitation services which include the people living nearby SNAB and those who are aware and capable to reach it. An organized clinical low vision service was first established in March 2005 at Makkah Eye Complex followed by a clinic established in October 2006 at Alwalidain Eye hospital.

The aim of this study was to provide information about the main causes of low vision and its effect on the visual functions and mobility in the blind center at Khartoum.

MATERIAL AND METHODS
A voluntary sample recruited from the SNAB and Elkur Institute was employed to identify the study subjects. The leaders of SNAB and Elkur Institute were informed of study protocol and asked to assist with information and announcement of subjects. The subjects who attended the household were invited for the detailed eye examination. A verbal consent was obtained from all subjects agreed the protocol. Examination was done using portable equipments and devices that are essentially similar to those found in the low vision clinics. The same conditions and parameters were established for each subject in order to maintain uniformity in testing conditions. The battery of examinations applied in this study aimed to investigate the visible structural changes and to detect functional disorders which assumed essential for determining visual impairment. As well the observation of the subject behaviour and his physical status can provide an insight to the severity of the problem. The clinical
procedures are categorized as follows: (a) functional tests: Log MAR visual acuity testing, Pelli-Robson contrast sensitivity testing, confrontation and Amsler grids visual field testing, and colour vision testing by Colour Vision Testing Made Easy (CVTME). (b) eye examination: anterior segment was examined with a torch light and magnifier, and fundus was examined with a direct ophthalmoscope. In addition, the refraction was performed both objectively and subjectively to detect any large refractive error neglected and if substantial improvement in acuity can be achieved with conventional lenses. A trial testing of telescopes and magnifiers was done to indicate the subjective response to these devices. A positive response will reflect the requirement of advanced low vision service and referral for the case.

RESULTS
A total of 171 subjects agreed to participate in this study. Five subjects were not included in the analysis because the visual acuity in the better eye was more than 0.5 log MAR or (6/18 Snellen equivalent). A total of 66 out of 166 (39.7%) subjects' case notes represented the Low Vision (LV) group after the functional tests and have shown some visual improvement with low vision devices LVDs. The remaining 100 (60.3 %) subjects' case notes represented the blind group (BL) after the functional tests and their mobility was affected. Data were analyzed using the Statistical Package for Social Sciences (SPSS) version-10. All tests were two sided and the results were quoted in proportions with Confidence Interval (CI) at 95% level. Therefore, a probability (P) value ≤ 0.05 was taken to indicate statistical significance for all analysis. T-test or Chi-Square test (p) was used to identify differences in proportions and Spearman correlation (r) was used to identify association between variables.

Low vision subjects (66): The age of the subjects ranged from 6 to 65 years; 48 (72.7 %) were males and 18 (27.3 %) were females (with ratio of 2.6:1). Log MAR visual acuity: in practice of log MAR visual acuity testing the lowest possible visual acuity (VA) score achieved was 2.1 log MAR. However, for data analysis in this study instead of hand movement (HM) 2.2 log MAR was used, instead of perception of light (PL) 2.3 log MAR was used, and instead of no perception of light (NPL) 2.4 log MAR was used. Thus the minimum visual acuity achieved was 2.4 in right and left eyes, the best VA of right eye was 0.6 log MAR and for left eye was 0.9 log MAR. The cross-tabulation showed that 17(25.75%) subject had equal distance visual acuity in two eyes and 49(74.25%) had unequal visual acuity in two eyes. Visual acuity was not statistically significant between right and left eye (r = -0.099) and T-test (P = 0.380).

Pelli-Robson contrast sensitivity: the minimum contrast sensitivity (CS) 0.00 log unit was found in right and left eyes, the best CS of right eye was 1.65 log unit and the best CS of the left eye was 1.05 log unit. The cross tabulation shows that 24(36.4 %) subjects had equal contrast sensitivity of the two eyes and 42(63.6%) subjects had unequal contrast sensitivity in two eyes. Contrast sensitivity was not statistically significant between the two eyes (r = -0.139) and T-test (P = 1.00). Table (1) shows that the correlations and T-test between the distance log MAR visual acuity (VA) and Pelli-Robson contrast sensitivity (CS) performed in each eye separately were highly significant.

<table>
<thead>
<tr>
<th>Pairs</th>
<th>Correlations</th>
<th>T-test</th>
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<tbody>
<tr>
<td>VA and CS of right eye</td>
<td>(r = -0.743) (P &lt; 0.001)</td>
<td>(T = 14.035) (P &lt; 0.001)</td>
</tr>
<tr>
<td>VA and CS of left eye</td>
<td>(r = -0.810) (P &lt; 0.001)</td>
<td>(T = 12.984) (P &lt; 0.001)</td>
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The confrontation test: the cross-tabulation of the confrontation test showed that only 10 (15.1%) subjects had fair visual field in both eyes. 15 (22.7%) subjects failed to see the testing object with right eyes and other 20 (30.3%) of subjects failed to see the testing object with left eyes. The remaining 21 (31.9%) had shown constricted visual field in both eyes.

Amsler test: the cross-tabulation of Amsler test showed that only 7 (10.6%) subjects have seen the chart normally in both eyes. 28 (42.4%) subjects failed to see the chart with right eyes and other 31 (47.0%) subjects failed to see the chart with left eyes.

Colour vision test: 60 (90.9%) subjects failed the screening of Colour Vision Test Made Easy (CVTME) and only 6 (9.1%) subjects passed the screening.

Refraction: the cross-tabulation in refraction showed 49 (74.2%) of subjects had similar refractive error in both eyes and 17 (25.8%) of subjects had different refraction in the two eyes. Hypermetropia found in 19 (28.7%) both eyes compared to myopia found in 4 (6.06%) and only 5 (7.5%) had normal refraction in both eyes. The remaining 38 (57.7%) had significant astigmatism and anisometropia.

| Table 2: Improvement of vision (vertical) by low vision devices (horizontal) |
|------------------|------------------|------------------|
|                  | Yes              | No               | Total            |
| Spectacle lenses | 27 (40.9%)       | 39 (59.1%)       | 66 (100%)        |
| Telescopes       | 61 (92.4%)       | 5 (7.6%)         | 66 (100%)        |
| Magnifiers       | 47 (71.2)        | 19 (28.8%)       | 66 (100%)        |

Low vision devices: Table 2 shows high improvement of vision was achieved by telescopes followed by magnifiers and spectacles respectively. The cross-tabulation showed an improvement achieved by spectacle lenses and telescopes was 27 (40.9%) while the improvement achieved by telescopes only was 34 (51.5%). The improvement by spectacle lenses and magnifiers was 25 (37.8%) while the improvement achieved by magnifiers only was 22 (33.3%).

Mobility: 54 (81.8%) subjects have shown good mobility and only 12 (18.2%) subjects showed problems in their mobility. 9 of these 12 showed searching characteristics and 3 were dependent on cane for mobility (Figure 1).

Causes of low vision: six eye problems as shown in Figure 2 were identified as main causes of low vision in this study viz. 34 (36.4%) cataract complications (including aphakia), 14 (21.2%) retinitis pigmentosa, 10 (15.2%) corneal opacity, 9 (13.6%) optic atrophy, 6 (9.1%) different Choroidal/or retinal disorder, and 3 (4.5%) nystagmus. Some subjects had more than one eye disease causing low vision, and thus the total number of these figures will be more than the number of subjects with low vision.

Figure 1 Showing the mobility of subjects
DISCUSSION
In this study there were 5 people who had visual acuity of 6/18 or better and 66 subjects had vision between 3/60 and 6/18 (low vision). The people with low vision can be benefited with low vision aids. This indicates that the people referred to blind centre did not have proper eye check up before referral.

The log MAR-based tests have been widely accepted as providing an accurate and efficient measure of visual acuity and now established as the "Gold standard" for acuity measurement of children and adults. In the results the best mean visual acuity of two eyes was 1.668 log MAR ±0.452 SD with minimal standard error of mean 5.564E-02. This indicating a sever loss of vision. A wide range of visual acuity 0.6 log MAR to 2.4 (NPL) in 0.1 log step have been scored. These results are less likely to be achieved accurately with Snellen test specifically when the visual acuity is less than 6/60.

High contrast visual acuity is not only measurement of visual function, although it remains the most common test used. A contrast sensitivity test has often been recommended for evaluation of visual performance in visually impaired persons. The contrast sensitivity function has been proven to be more sensitive in early detection of eye diseases and can be a good predictor to the progressive or stable eye condition rather than a diminished visual acuity. The mean contrast sensitivity of two eyes equal to 0.363 log unit. 36.6% of right eyes and 45.5% of left eyes had shown no sensitivity to contrast (scored 0.00). 36.4% of subjects had scored equal contrast sensitivity and 63.6% of subjects had unequal contrast sensitivity in the two eyes, the correlation was very week (r = -0.139) and T-test was not significant (p =1.00). These results indicate that most of subjects have sever loss of contrast sensitivity despite only five subjects in this group had shown acceptable contrast sensitivity in one eye (contrast better than1.05 log unit). In Table 1, a high correlation was found between log MAR visual acuity test and
contrast sensitivity test on right eyes and on left eyes. Although contrast sensitivity appeared to be worse than visual acuity, the statistically significant T-test confirmed that the two tests are different but a strong correlation exists between them. A population-based study of 2520 people by West et al\(^9\) showed that most persons were not disabled until they had significant visual acuity loss > 1.0 log MAR (worse than 6/60) or contrast sensitivity 0.9 log unit or worse. They found that visual acuity worse than 0.2 log MAR (6/9) or contrast sensitivity worse than 1.4 log unit was found disabling for reading purpose.

Defects in the visual field reflect the structural or functional abnormalities in ocular and neural mechanism of vision. However, the main purpose of visual field assessment in this study was to determine roughly any peripheral field defect with confrontation test and central disorders or scotomas with Amsler test, as these defects impact on tasks such as reading and mobility. The findings of these two tests reveal that a visual field was highly affected in our study subjects and this should not to be neglected when assessing low vision patients.

Gross colour discrimination with (CVTME) was used in this study to indicate only if the subject is able to identify colours or not. Although the colour differences of (CVTME) are greater than in Ishihara's test, but the sensitivities and specificities of plates test as whole are very similar to those in Ishihara test. Only six subjects (9.1%) of the group had successfully passed the test. Since in the present study each subject was examined binocularly it is expected that the discrimination of colour was dominantly detected by the better eye. Nevertheless, McCulley, et al\(^10\) concluded that, in patients with poor vision, it is not always clear whether errors on colour vision testing are attributed to an abnormality in colour vision or simply related to acuity loss.

The majority of subjects in this study have shown some refractive error which was basically not corrected. However, correction of refractive error alone would not reduce the burden of visual impairment in this population due to the compound ocular diseases. The findings indicate that the contribution of refractive error is high. Therefore, the present results assume that the refractive error was an additional source which reduced the visual capability in this group.

It is obvious that the low vision devices (LVDs) are essential part of low vision management. Nevertheless, the results shown in Table 2 clearly demonstrate that significant improvement of vision has been provided when (LVDs) tried for the low vision group. However, it is interesting to note that (40.9%) of subjects have shown positive improvement of vision by using spectacle lenses in all types of refraction. In conclusion using many optical devices predicted more visual successes. However, Leat et al\(^11\) who have shown that 89% of their low vision patients received low vision service reported benefits and 81% regularly used their low vision devices.

No doubt a profound visual impairment has a severe impact on mobility and some subjects included in this study are unable to visually detect some hazards at a safe distance. It is obvious that the mobility and most activities of daily living are associated with visual performance. This was already confirmed by different studies including a survey performed by Tsang\(^12\) of 171 people with low vision. His result showed that more than 90% of subjects handled daily living task with their residual vision in various extent, half of subjects required low vision aids for reading and writing, 70% did not use a cane for orientation and mobility.

There is lack of published data concerning specifically the causes of low vision in Sudan. Sid Ahmed\(^13\) has done a study on causes of blindness in the same institute in 1988, but did not mention causes of low vision. The main causes of blindness in her study were 22.6% glaucoma, 16.6% congenital cataract, 14% retinitis pigmentosa, 12% optic atrophy, 10% microphthalmos and anophthalmos, 6.6% keratoconus and abnormalities of cornea, and 2% coloboma.

The current causes also are some what similar to the international reports coming
from developing countries. Herse and Gothwal\textsuperscript{14} from India in a retrospective hospital based survey reported the main causes of low vision (VA<6/18 to 3/60); as cataract 21.4%, glaucoma 14%, diabetic retinopathy 13%, and retinitis pigmentosa 10.7%; while the main causes of blindness (VA<3/60 in the better eye) in their study were glaucoma 16.3%, diabetic retinopathy 13.2%, corneal opacities 11.6%, and retinitis pigmentosa 11.6%. Omer et al\textsuperscript{15} from Malaysia showed the main causes of low vision seen in 275 patients in the low vision clinic as 18.2% cataract and aphakia, 12.4% structural defects including nystagmus, 10.5% retinitis pigmentosa, 7.3% diabetic retinopathy, 7.3% age-related macular degeneration.

In our study, the statistical analysis showed that all causes are not significantly different in their effect on log MAR visual acuity (r = 0.089 and p = 0.930 in right eyes; r = -0.065 and p = 0.257 on left eyes), contrast sensitivity (r = -0.118 and p = 0.538 on right eyes; r = -0.055 and p = 0.884 on left eyes), colour vision (r = -0.092 and p = 0.143), and mobility of subjects (r = -0.129 and p = 0.289).

References
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