

Childhood blindness and visual impairment among children attending Ruharo Eye Centre

Umesumbu SC, Bwonya BD, Onyango J

Mbarara University of Science and Technology, Uganda

Corresponding author: Dr. S.C. Umesumbu. Email: drumesumbush@yahoo.fr/drumesumbush@gmail.com

ABSTRACT

Objective: To determine the magnitude, causes of blindness and visual impairment and spectacle use among children attending Ruharo Eye Centre (REC).

Methods: This was a hospital based descriptive cross sectional study, conducted at REC. The study population comprised all children below 16 years attending REC during the period of data collection and targeted all children presenting vision below 6/18 in the better eye and who consented/assented to participate in the study. The WHO CB questionnaire was used, a variety of visual acuity tests were used depending on the age, children were examined and treated and those with refractive error were refracted and prescribed glasses. Stata11 software was used for analysis.

Results: In 3 months, a total of 1082 children were examined with 54% (586/1082) male. The mean age was 7.32 years (CI 95% 7.04-7.59). Sixty seven children (6.19%) were visually impaired or blind with a sex ratio Female/Male = 1:1. The magnitude of childhood blindness was 2.50% [95% CI=1.58-3.48] (27/1082) and the total magnitude of visual impairment was 3.70% [95% CI = 2.58-4.48] (40/1082).

The major site of abnormality leading to childhood blindness and visual impairment was the lens accounting for 26.86% (18/67) of all the cases. Fifty percent of these were post cataract surgery. Refractive error was the leading cause of visual impairment accounting for 43% (13/28) of the cases. Eighty eight percent (59/67) of the causes of childhood blindness and visual impairment were avoidable. Only 8% (2/24) of children with confirmed refractive errors, were effectively seen using the prescribed optical correction.

Conclusion: In this study, 2.5% of children seen at REC were blind; lens abnormalities were the major cause of childhood blindness and majority of the children who required glasses and low vision devices were not using them.

Key words: Childhood blindness, Visual impairment, Use of glasses, Ruharo Eye Centre

INTRODUCTION

Childhood Blindness (CB) is one of the five eye conditions established as immediate priorities for control by the World Health organization (WHO) Vision 2020 – The “Right to Sight” global initiative¹.

Children who are born blind, or who become blind and survive, have a lifetime of blindness ahead of them and constitute a serious burden to themselves, their family and the community with all the associated emotional, social and economic costs. The number of “blind years” due to blindness in children is almost equal to the number of blind years due to cataract in adults because of long life expectancy in children² and yet 50% of the causes of blindness are either preventable or treatable¹.

Records at Ruharo Eye Centre (REC), Southwestern Uganda, show that childhood blindness/visual impairment constitute an important cause of consultations and hospitalization. There is need for detailed documentation in regards to causes of blindness

and visual impairment among children seen at REC. Furthermore the clinic dispenses refractive glasses and low vision devices but little information is known if the patients are using them. Failure to use prescribed vision devices and refractive glasses may constitute incomplete management of childhood blindness/visual impairment.

Therefore, the purpose of this research was to find out the magnitude and causes of childhood blindness and visual impairment at Ruharo Eye Centre and establish the compliance level of use of prescribed refractive glasses and low vision devices.

This research had three specific objectives: To determine the magnitude or the proportion of children with blindness and visual impairment among children attending REC; To establish the causes of childhood blindness and visual impairment among children attending REC and to determine the proportion of children using prescribed glasses and low vision devices among children with visual impairment attending Ruharo Eye Centre.

MATERIALS AND METHODS

This was a hospital based descriptive cross sectional study. The study was conducted at Ruharo Eye Centre, a Department of Ruharo Mission Hospital, of Ankole Diocese dealing with eye care in Mbarara Municipality, Mbarara district, south western Uganda. REC is one of the largest eye centers in Uganda with an Outpatient Department (OPD), low vision / paediatric ophthalmology service, an optical unit, a 41 bed capacity ward, an operating theatre and a local eye-drop production unit.

The study population comprised of all children below 16 years attending REC during the study period. This study included all children who presented with visual acuity below 6/18 in their better eye.

The sample size was estimated using stata 11. With a hypothesized value of 0.0264, and a postulated value of 0.0410 from a study done in Yemen³; using stata 11, one sample comparison of proportion to the hypothesized value with a power of the test set at 0.80 and the type of test being two sided test, with a level of significance of 0.01, the estimated sample size was 1086 children.

The research included all children aged less than 16 years, whose presenting vision was below 6/18 in the better eye and whose parents or attendants consented to participate in the study. There was a provision for older children of more than 10 years to ascent.

All patients whose parents or themselves (if above 10 years) refused to sign the consent (Ascent) form were excluded. Children whose visual acuity could not be determined because of communication, age or other disability despite the use of several visual acuity tests relevant for age were also excluded. Nevertheless we did not exclude any child obviously, clinically blind children.

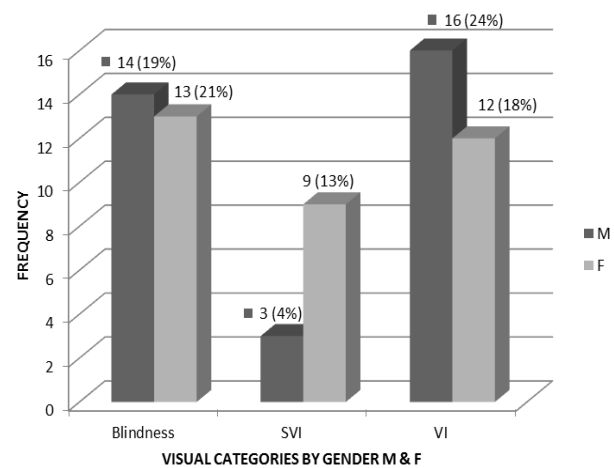
A standardized data collecting tool for blindness and visual impairment in children, developed by WHO in collaboration with ICEH was used for this study⁴. This questionnaire comprises the following assessment sections: personal details of the child (age, home town, age at onset, family history); visual assessment (distance vision, functional vision, visual field); general assessment (additional disabilities, etc.); previous ocular history; eye examination; refraction and low vision assessment; major site of abnormality leading to visual loss for the child; action needed (optical, surgical and medical); prognosis for vision and diagnosis⁴. This questionnaire did not include the third objective and annex questionnaire was added to investigate the rate of use of prescribed glasses and/or optical devices.

The equipment used for determining visual acuity included: Cardiff chart, Dot test, Lea test symbol, E chart and Log MAR chart. For the examination of the anterior segment, a torch or direct ophthalmoscope provided light, magnifying loupes, and slit lamp.

RESULTS

General information: In 3 months, a total number of 1082 children were examined and 7 children were excluded; 54% were males and the rest were females. The mean age was 7.32 years (CI 95% 7.04-7.59), the children examined came from 10 ethnic groups and the major ethnic group was Banyankole-Bakiga. There were 67 children identified with either blindness or impaired vision; 51% were females.

Figure 1: Distribution of blindness and visual impairment by gender (n=67)



Out of the 67 children with impaired vision, 40.30% (27/67) were blind with a sex ratio female/male of 1:1, 17.91% (12/67), had severe visual impairment the sex ratio female/male of 3:1, and 41.79% (28/67) had visual impairment (sex ratio female/male of 3:4). Most of the patients had the onset of the condition since birth 53.73% while 35.82% of cases started after the first birth day. The majority (90%) of the patients had no family history of visual impairment. Only 4.48% of children with childhood blindness and visual impairment had a parent history of consanguinity. Of the children with blindness and visual impairment, 9% were found to have associated disabilities.

Magnitude of childhood blindness: During the data collection period, 1082 children were examined and 27 found to be blind hence, the magnitude of childhood blindness was 2.50% [95% CI=1.58-3.48] (27/1082). Among the 27 blind children, the mean age was 4.34 years [95% CI =2.37- 6.31], 52% (14/27) were males and the rest females with a sex ratio F/M = 1:1.

Magnitude of visual impairment (moderate and severe): The study had recruited 28 children with moderate visual impairment and 12 with severe visual impairment. The magnitude of severe visual impairment was 1.11% [95% CI= 0.48-1.74] and 2.59% [95% CI= 1.65-3.53] for moderate visual impairment; hence, the total magnitude of visual impairment was 3.70% [95%

CI = 2.58-4.48] (40/1082). Of the 40 children with visual impairment, the mean age was 8.42 years [95% CI = 6.99-9.85], 52.5% (21/40) were females and the rest males with a sex ratio F/M = 1:1.

Causes of childhood blindness and visual impairment: The causes of childhood blindness and visual impairment were classified by the anatomic site of the disease, its

etiology related to the time of onset and finally whether the disease is avoidable or not avoidable¹. These are presented within 3 categories (blindness, moderate and severe visual impairment). Only the anatomic site of abnormality and whether the disease is avoidable or not are used to present the causes of childhood blindness and visual impairment in this study.

Table 1: Causes of childhood blindness by site of abnormality (n = 27)

| Site | Male | Female | Total (%) [95%CI] |
|-----------------------|-----------|-----------|--------------------------------|
| Lens | | | |
| Operated cataract | 0 | 3 | 3(11.11) |
| Non operated cataract | 3 | 0 | 3(11.11) |
| Total lens | 3 | 3 | 6(22.22) [95% CI = 6.54-37.9] |
| Cornea | | | |
| Corneal scar | 3 | 2 | 5(18.51) |
| Total cornea | 3 | 2 | 5(18.51) [95% CI = 3.86-33.16] |
| Retina | | | |
| Retinoblastoma | 2 | 3 | 5(18.51) |
| Total retina | 2 | 3 | 5(18.51) [95% CI = 3.86-33.16] |
| Optic nerve | | | |
| Optic atrophy | 3 | 1 | 4(14.81) |
| Retrobulbar neuritis | 0 | 1 | 1(3.70) |
| Total optic nerve | 3 | 2 | 5(18.51) [95% CI = 3.86-33.16] |
| Whole globe | | | |
| Buphthalmos | 1 | 1 | 2(7.40) |
| Microphthalmos | 1 | 1 | 2(7.40) |
| Total whole globe | 2 | 2 | 4(14.8) [95% CI = 1.41-28.19] |
| Cortical blindness | 1 | 1 | 2(7.40) [95% CI = -2.47-17.22] |
| Total | 14 | 13 | 27(100) |

Causes of childhood blindness in the target population: The leading causes of childhood blindness by site in this study was lens abnormalities with 22.22% [95% CI = 6.54-37.9] (6/27) and 50% of them were operated cataract.

Table 2: Avoidable and unavoidable causes of childhood blindness (n= 27)

| Avoidable | Males | Females | Total (%) [95% CI] |
|---|-----------|-----------|-------------------------------|
| Preventable | | | |
| Operated cataract related complications | 0 | 3 | 3(11.11) |
| Corneal scar | 3 | 2 | 5(18.52) |
| Total preventable | 3 | 5 | 8(29.63) [95% CI=12.41-46.85] |
| Treatable | | | |
| Non operated cataract | 3 | 0 | 3(11.11) |
| Retinoblastoma | 2 | 3 | 5(18.52) |
| Buphthalmos/Glaucoma | 1 | 1 | 2(7.41) |
| Retrobulbar neuritis | 0 | 1 | 1(3.70) |
| Cortical blindness | 2 | 0 | 2(7.41) |
| Total treatable | 8 | 5 | 13(48.14)[95%CI=29.29-66.99] |
| Total avoidable | 11 | 10 | 21(77.78)[95%CI=62.10-93.46] |
| Unavoidable | | | |
| Optic atrophy | 3 | 1 | 4(14.81) |
| Microphthalmos | 1 | 1 | 2(7.41) |
| Total unavoidable | 4 | 2 | 6(22.22)[95% CI=6.54-37.9] |
| Grand Total | 14 | 13 | 27(100) |

In this study, 77.78% [95%CI=62.10-93.46] (21/27) of the causes of childhood blindness was avoidable.

Table 3: Distribution of visual impairment by site of abnormality (n= 40)

| Site | SVI | MVI | Total (%) [95%CI] |
|------------------------------------|-----|-----|------------------------------|
| Refractive error (Norm globe) | | | |
| Myopia | 1 | 10 | 11(27.5) |
| Hypermetropia | 0 | 2 | 2(5.00) |
| Total refractive error | 1 | 12 | 13(32.5) [95%CI=18-47] |
| Lens | | | |
| Operated cataract | 1 | 5 | 6 |
| Non operated cataract | 1 | 3 | 4(10.00) |
| Ectopia lentis | 1 | 1 | 2(5.00) |
| Total lens | 3 | 9 | 12(30.0) [95%CI=15.8-44.20] |
| Whole globe | | | |
| Operated glaucoma/buphthalmos | 2 | 3 | 5(12.5) |
| Non operated glaucoma/ buphthalmos | 1 | 2 | 3(7.50) |
| Total whole globe | 3 | 5 | 8(20.0) [95%CI=7.6-32.40] |
| Retina | | | |
| Retinoblastoma | 1 | 0 | 1(2.50) |
| Retinitis pigmentosa | 1 | 1 | 2(5.00) |
| Albinism | 1 | 0 | 1(2.50) |
| Total retina | 3 | 1 | 4(10.00) [95% CI =0.70-19.3] |
| Cornea(mainly scars) | 2 | 1 | 3(7.50) [95%CI= -0.66-15.66] |
| Total | 12 | 28 | 40(100) |

Causes of visual impairment by site: The leading cause of visual impairment by site in this study was refractive errors with 32.5% [95% CI=18-47] (13/40) followed by lens disorders 30.0% [95% CI=15.8-44.20] (12/40).

Among the 40 children with visual impairment (moderate and severe), the leading cause is refractive error (32.5%), followed by lens abnormalities (30%).

Table 4: Avoidable and unavoidable causes of visual impairment by site (n=40)

| Avoidable | SVI | MVI | Total (%) [95% CI] |
|---|-----|-----|-----------------------------|
| Preventable | | | |
| Corneal scar | 1 | 1 | 2(5.0) [95% CI=-1.75-11.75] |
| Cataract/ surgery related complications | 1 | 5 | 6(15) |
| Total preventable | 2 | 6 | 8(20) [95% CI=7.4-32.4] |
| Treatable | | | |
| Refractive errors | 1 | 12 | 13(32.5) |
| Non operated cataract | 1 | 3 | 4(10) |
| Buphthalmos/Glaucoma | 3 | 5 | 8(20) |
| Retinoblastoma | 1 | 0 | 1(2.5) |
| Keratoconus | 1 | 0 | 1(2.5) |
| Ectopia lentis | 1 | 1 | 2(5.0) |
| Total treatable | 8 | 21 | 29(72.5)[95%CI=58.66-86.34] |
| Total avoidable | 10 | 27 | 37(92.5)[95%CI= 84.34-100] |
| Unavoidable | | | |
| Retinitis pigmentosa | 1 | 1 | 2(5.0) |
| Albinism | 1 | 0 | 1(2.5) |
| Total unavoidable | 2 | 1 | 3(7.5)[95%CI=-0.66-15.66] |
| Grand Total | 12 | 28 | 40(100) |

The majority (92.5%) [95%CI= 84.34-100] of the cases of visual impairment by site were avoidable in this study.

Use of prescribed glasses and devices: Of the 40 visually impaired children identified, 30 of them needed optical correction. Among the 30 children who needed optical correction, only 80% (24/30) got optic device prescription. Among the 24 children who got optical prescription, 66.67% (16/24) were dispensed with glasses and LV devices. Only two (8%) children were identified using the device dispensed and were seen using them.

DISCUSSION

Magnitude of childhood blindness and visual impairment: In this study, the magnitude of childhood blindness was 2.50% [95% CI=1.58-3.48] (27/1082), the magnitude of severe visual impairment was 1.11% [95% CI= 0.48-1.74] and 2.59% [95% CI= 1.65-3.53] for moderate visual impairment; hence, the total magnitude of visual impairment was 3.70% [95% CI= 2.58-4.48] (40/1082).

These results are expected to be higher than the WHO estimated magnitude for sub-Saharan region², because of the different study settings. A hospital study like the current study is expected to have a high magnitude of childhood blindness because; it biasly attracts children with eye problems. However, findings from similar hospital settings appear to be consistent with these findings. Studies from Middle East reported range of 1.7- 4.0% of children attending eye hospital to be blind^{3,5}.

Being a hospital based study; there is already a bias in estimating the magnitude as all the children coming to the hospital are already having an eye problem. This can explain the difference between these findings and community based studies using key informant methods which all have low magnitudes⁶⁻⁸.

Causes of childhood blindness: The leading causes of childhood blindness by site in this study was lens abnormalities with 22.22% [95% CI = 6.54-37.9] (6/27) and 50% of them were operated for cataract.

It was demonstrated from WHO that there is a wide regional variation in the causes of blindness in children². These findings are consistent with the estimates from WHO stating that in all regions of the world, cataract,

retinal diseases (mainly hereditary retinal dystrophies) and congenital abnormalities affecting the whole eye are significant causes of blindness². They are also consistent with a similar study done in Yemen which found that majority of blindness in children were due to cataract (20%), glaucoma (17.8%) and retinal disorders (13.3%)³.

Although settings are different, these findings are also consistent with the two studies done in Uganda on childhood and visual impairment which found that the lens has been the overall cause of childhood blindness and they found that 50% of blindness due to cataract were from operated cataracts^{7,9}.

The results are however different from other studies done elsewhere regardless of the setting. In hospital based studies, results vary; in Saudi Arabia, the most common anatomical cause of bilateral blindness was optic nerve diseases in 40%, retinal disorders in 32% and cataract in 7%⁵. In Nigeria, Ecwa eye hospital, corneal causes were responsible for blindness in 55%, and lens opacities in 13%¹⁰.

In community based and blind school studies the results are also different owing to the geographic area; in Nigeria it was discovered that corneal opacities due to measles, vitamin A deficiency, infectious keratitis, and trauma, was the leading cause of childhood blindness with 55% of cases followed by cataract at 15%⁶. In Iran the posterior segment was found as the primary cause of blindness in children (63%) followed by the whole globe¹¹, almost the same picture was seen in China with the posterior segment leading the causes of blindness in all the eight blind children in the survey¹², in south India, congenital abnormalities were the leading cause of blindness (35.7%) followed by the retina 19.9%, the cornea (14.9%) then the lens (11.4%)¹³. In the United States, the leading cause of childhood blindness was cortical blindness at 19%, while 12% of the children had visual loss from optic atrophy and optic nerve hypoplasia¹⁴. A survey done in schools for the blind in East Africa (Malawi, Kenya, Tanzania and Uganda) has got also different findings showing that cornea was the leading site of blindness (19%) followed by the whole globe (15.7%), the retina (15.4%) and the lens (13.1%)¹⁵.

The difference in geographic area and the study sites may explain these differences. It is possible that Nigeria is still struggling with measles and vitamin A

deficiency and the survey in East Africa which studied the changes in 14 years in blind school recruited possibly children who became blind before 2000 when vitamin A deficiency and measles were still a serious problem in Uganda and in most eastern African countries. However in middle income countries like India, Saudi Arabia or in high income countries like USA, the difference in findings is understandable; cataract and corneal opacities are less causes of blindness.

Nevertheless, cataract is still a problem in our setting even if more than 50% were already operated. Other studies in different settings found similar results^{7,9}. It is possible that blind children with cataract are brought late for surgery when amblyopia has already set in or due to poor surgical outcomes and lack of postoperative refractive corrections. Research currently being carried out at Ruharo Eye Centre determining the causes of poor outcomes following cataract surgery, may provide an answer to this. In this study, retinoblastoma was the third leading cause of childhood blindness. This could be due to the fact that Ruharo Eye Centre is currently a national centre for the treatment of children with retinoblastoma in Uganda.

Causes of visual impairment: Among the 40 children with visual impairment (moderate and severe), the leading cause is refractive error (32.5%), followed by lens abnormalities (30%).

Refractive errors are known as leading causes of visual impairment and WHO estimates in our region a prevalence of 0.24% in children aged 5-15 years^{1,16}.

These findings are consistent with other studies done elsewhere regardless of the setting. In hospital based studies similar results were found like in Yemen which demonstrated that bilateral visual impairment was mainly due to refractive error (29.2%), keratoconus (18.7%), retinal disorder (18.7%) and cataract (8.3%)³, in Saudi Arabia, the leading causes of bilateral visual impairment were refractive errors (16%), corneal disorders (16%), retinal disorders (12%) and cataract (11%)⁵.

In community based studies almost the same picture was found in Nigeria where refractive error and corneal opacities were the top leading causes of visual impairment⁶. Refractive errors constitute a global issue for Vision 2020 and are being addressed. Reasons advanced for non-correction of refractive errors in children aged 5-15 years are: affordability

and availability, lack of screening¹⁶, and cultural disincentives may also play a role. The third objective of the current study addresses partially this issue.

Of the 67 children with VI/CB, 10.45% (7/67) were due to preventable causes like corneal opacities following ophthalmia neonatorum, anterior staphyloma, use of traditional eye medicine, 77.6% (52/67) were due to treatable causes such as cataract, glaucoma, retinoblastoma, and the total proportion of children with avoidable causes of childhood blindness and visual impairment was 88% (59/67).

Gordon *et al*¹ found that among children with blindness and visual impairment, 30-70% of the causes are avoidable. The findings from this study are slightly above the estimates but the trend is the same with what almost all researchers cited in their work regardless of the type and setting of the study. In Nigeria, in a hospital based study, 58.6% of the cases were due to avoidable causes, 38.4% being preventable and 19.2% treatable¹⁰.

In population based studies, the proportion of avoidable causes varies from 50 to 100%. In Bulambuli, Uganda, it was 80%⁷, in Nigeria 100%⁶, in Bangladesh 63.6%¹⁷ and in Malaysia 50.5%¹⁸. The huge difference between this finding and the Malaysian study is due to the design, and the setting; the Malaysian study was a survey in the blind school which also excluded preschool children and preverbal children, while in the hospital based study in Nigeria, only children who were 1 year and above were recruited. This may also explain the slight difference.

Use of prescribed glasses: Optical correction (glasses and low vision devices) was needed in 30 patients. Twenty four (80%) of them got an optical prescription in the past, only 37% (9/24) of patients declared using prescribed glasses and evidence of the use of prescribed optical correction, was demonstrated only in 2 (8%) of patients who came using the optical correction at REC. Generally there is poor compliance with spectacles for many reasons: prismatically induced optical aberrations in high power lenses, narrow visual fields and social ostracism due to unattractive thick lenses being some of the reasons¹⁹.

These results are consistent with a study done in Oaxaca, Mexico evaluating the use of donated glasses through a school program (HKI/ Ver. Bien program) which found that only 13.9% of the children were

wearing the glasses. Of those not wearing them, 34% had the glasses with them²⁰. It is different from another study done in Tehran, Iran Republic whereby the rate of use of glasses was 63%²¹. Although our findings are similar with Mexico study, the study population was different; there they considered even patients with a normal vision (according to WHO criterion) but who needed correction for small refractive errors, and all the glasses were given free of charge, this study dealt with the visually impaired patients who were also required to purchase the glasses. This study did not find out why children were not using the glasses.

CONCLUSIONS

- (i) In this study, the magnitude of childhood blindness was 2.50% [95% CI=1.58-3.48] while visual impairment was 3.70% [95% CI = 2.58-4.48] with 2.59% [95% CI= 1.65-3.53] moderate visual impairment and 1.11% [95% CI= 0.48-1.74] severe visual impairment.
- (ii) Lens abnormalities were the leading cause of childhood blindness (22%) [95% CI = 6.54-37.9] and half of them following cataract surgery, whereas refractive errors (32.5%) [95% CI18-47] were the leading cause of visual impairment.
- (iii) Majority of causes of childhood blindness 77.78% [95% CI 62.10-93.46] and visual impairment 92.5% [95% CI 84.34-100] were avoidable.
- (iv) Majority (92%) [95% CI= 81.5-100] of the children who required glasses and low vision devices were not using them.

RECOMMENDATIONS

- (i) Further study should be done to establish why cataract and more so operated cataracts are still the leading causes of childhood blindness and visual impairment.
- (ii) Further study should be done to find out why children with visual impairment do not use the prescribed glasses and optical devices.

ACKNOWLEDGEMENTS

To the Department of Ophthalmology of Mbarara University of Science and Technology (Prof Amos

Twinamasiko, Prof Kenneth Kagame, Dr Lisbon Aliraki, Dr Sam Ruvuma, Dr Freddy Mbumba and my family for the support. To low vision therapists and opticians at Ruharo Eye Centre (Johnson, Nelson, Phoebe, Andrea, Boma), and statistician Patrick for the hard work. The study was funded by Christoffel Blinden Mission.

REFERENCES

1. Gordon, Darwin, Robert, Sheila. The epidemiology of eye diseases. Third edition ed. London: Imperial College Press.; 2012.
2. Gilbert C, Foster A. Childhood blindness in the context of VISION 2020 —The Right to Sight. *Bull World Health Org.* 2001; **79**(3): 227–232.
3. Bamashmus M, Al-Akily S. Profile of childhood blindness and low vision in Yemen: a hospital-based study. *Eastern Mediterranean Health J.* 2010; **16**(4):425-428.
4. Gilbert C, Foster A, Negrel A, Thylefors B. Childhood blindness: a new form for recording causes of visual loss in children. *Bull World Health Org.* 1993; **71**(5): 485-489.
5. Khalid F, Hisham E, Shucri S. Pattern of childhood blindness at a referral center in Saudi Arabia. *Ann Saudi Med.* 2005; **25**(1):18-21.
6. Muhammad N, Maishanu NM, Jabo AM, Rabi MM. Tracing children with blindness and visual impairment using the key informant survey in a district of north-Western Nigeria. *Middle East Afr J Ophthalmol.* 2010; **17**(4):330-334.
7. Bwonya D. Childhood blindness and its impact: key informant method in Bulambuli District, Eastern Uganda. Dissertation. [Project report]. In press 2011.
8. Xiao B, Fan J, Deng Y, Ding Y, Muhit M, Kuper H. Using key informant method to assess the prevalence and causes of childhood blindness in Xiu'shui County, Jiangxi Province, Southeast China. *Ophthalmic Epidemiol.* 2011; **18**(1):30-35.
9. Waddel K. Childhood blindness and low vision in Uganda. *Eye.* 1998; **12**:184-192.
10. Olatunji F, Kirupatananthan S, Aayanniyi A, A., Abuh S. Causes of childhood blindness at ECWA Eye Hospital, Kano, Nigeria. *Afr J Med Sci.* 2009; **38**(1): 29-32.

11. Rasavi H, Kuper H, Resvan F. Prevalence and causes of severe visual impairment and blindness among children in the lorestan province of Iran, using the key informant method. *Ophthalmol Epidemiol.* 2010; **17**:330-334.
12. Xiao B, Fan J, Deng Y, *et al.* Using the key informant method to assess the prevalence and causes of childhood blindness in Xiu'shui county, Jiangsi Province, Southeast China. *Ophthalmol Epidemiol.* 2011; **18**:30-35.
13. Gogate P, Kishore H, Dole K. The pattern of childhood blindness in Karnakata, South India. *Ophthalmol Epidemiol.* 2009; **16**:212-217.
14. Steinkuller P, Lee D, Gilbert C, Foster A, Collins M, David K. Childhood blindness. *J AAPOS.* 1999; **3** (1):26-32.
15. Njuguna M, Msukwa G, Shilio B, Tumwesigye C, Courtright P, Lewallen S. Causes of severe visual impairment and blindness in children in school for blind in Eastern Africa: Changes in last 14 years. *Ophthalmol Epidemiol.* 2009; **16**:151-152.
16. Serge R, Donatella P, Silvio P, Gopal P. Global magnitude of visual impairment caused by uncorrected refractive errors in 2004. *Bull World Health Org.* 2008; **86**:63-70.
17. Muhit M, Shah S, Gilbert C. Causes of severe visual impairment and blindness in Bangladesh: A study of of 1935 children. *Br J ophthalmol.* 2007; **91**:1000-1004.
18. Patel D, Tajunisah I, Gilbert C, Subrayan V. Childhood blindness and severe visual impairment in Malaysia: a national study. *Eye.* 2011; **25**(4):436-442.
19. Creig S, David T. Paediatric ophthalmology and starbismus. Fourth ed. San Francisco: Elsevier Saunders 2013.
20. Aaron M, Nathan C, Nita P, Amy R, Estes P, Silvia T, *et al.* Factors associated with spectacle-wear compliance in school-aged Mexican children. *Invest Ophthalmol Vis Sci.* 2006; **47**(3):925-928.
21. Fotouhi A, Hashemi H, Raissi B, Mohammad K. Uncorrected refractive errors and spectacle utilisation rate in Tehran: the unmet need. *Br J Ophthalmol.* 2006; **90**:534-537.