Causes of severe visual impairement and blindness among children: a case of Mbarali District in Southern Tanzania

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ABSTRACT

Objective: To determine the anatomical causes and diagnosis leading to severe visual impairment and blindness and explore their relationship to demographic characteristics among children in Mbarali district, Southern Tanzania.

Materials and methods: Key informants were trained on how to identify children with poor vision and other ocular abnormalities. Key informants identified, listed and referred for examination children with poor vision, white pupillary reflex, squint, and smaller and bigger than normal eyes. Children with a visual acuity of <6/60 in the better eye were recruited for the study. Cycloplegic refraction, anterior and posterior segment and ocular alignment examination were performed to ascertain the cause of Severe Visual Impairment (SVI) or Blindness (BL).

Results: Sixty six children had a visual acuity (VA) of <6/60. Seventy percent were 5 years or more. The mean age was 9.18(±4.42) (SD =4.42) years. Thirty five (53%) were females. Forty eight (72.7%) had SVI (VA<6/60) while 18 (27.3%) were BL (VA<3/60). Lens related conditions (27.3%), uncorrected refractive error (15.2%) and corneal related disorders (13.6%) were the commonest causes of SVI/BL. Majority of children with lens related conditions (72.2%), uncorrected refractive error and congenital glaucoma (75%) were females, while all 6 children with cortical blindness were males. Lens related and cortical blindness conditions were commoner among under-five than among older children (6/20, 30% vs 12/46, 26%) and (4/20,20% vs 2/46, 4%). Un-operated cataract was the leading diagnosis causing SVI/BL. Only 4 patients were operated for cataract. There was only one patient with phthisis-bulbi related to keratomalasia.

Conclusion and Recommendations: Lens related conditions, specifically cataract was the leading cause of SVI/BL. Recruitment of an eye-doctor at Mbarali District Hospital and establishment of tertiary eye services at Mbeya Zonal Referral Hospital are recommended to enable identification, referral and comprehensive tertiary management of children with eye conditions.

INTRODUCTION

The prevalence and causes of BL in children vary between countries and are related to the socio-economic status[1]. In most low resource countries including those of Africa and Asia, the causes of SVI/BL are mainly avoidable mostly involving the cornea (vitamin A deficiency, measles infection and ophthalmia neonatorum) and lens (cataract)[2]. Improper management of corneal ulcers resulting from corneal conditions can lead to a corneal opacity or worse still a shrunken disorganized eye diagnosed as corneal scar and phthisis-bulb respectively. In the 1990s corneal scarring and phthisis bulbi secondary to measles were reported as the leading causes SVI/BL in Dodoma, Tanzania[5]. Cataract is the main lens related treatable cause of SVI/BL. Cataract surgical post-operative visual outcome depends on early, quality surgery with appropriate optical correction and regular and long term follow up[4]. Other common causes of SVI /BL are congenital glaucoma and retinopathy of prematurity.

VISION 2020 The Right to Sight global initiative targets the control of blindness in children by focusing on eliminating corneal related blindness, provision of appropriate surgery for children with cataract and immediate optical correction, screening for babies at risk of Retinopathy of Prematurity (ROP) and provision of glasses for significant refractive errors[5].

Most potentially blinding conditions in children can be prevented at the community level. However, the management of congenital cataract, congenital glaucoma and retinopathy of prematurity is challenging because such services can only be provided at a tertiary centre with

a Child Eye Health Tertiary Facility (CEHTF). The WHO recommends that there be 1 CEHTF per 10 million people in developing countries[5]. A number of countries in sub-Saharan Africa have established such centers according to the need while others like Tanzania have gone half way to meet this target due to the heavy investment required[6].

The causes of blindness in children have been noted to change in the last and current decades in relation to availability of services for children[7-9]. There are no recent studies on the causes of SVI/BL in children in Tanzania. The aim of the study was to determine the anatomical causes and diagnosis leading to SVI/BL and explore their relationship to demographic characteristics among children in Mbarali district, Southern Tanzania for planning purposes.

MATERIALS AND METHODS

Study setting and design

A population based cross sectional survey was conducted in March- April 2016 in Mbarali District in Mbeya Region Southern Tanzania. The district has a population of 300, 517 of which 138, 713 are children below 16 years.

Study population

All 138,713 children from birth to 15 years in the district were eligible for the study.

Inclusion criteria: Children < 16 years with a presenting visual acuity of <6/60 in the better eye who have been living in the district for 6 months prior to the survey and whose parents agreed to participate in the study.

Exclusion criteria: Children whose parents refused to allow their children to be examined.

Data collection procedures

Selection and training of key informants: One Village Health Worker (VHW) from each village was selected by the community for training, as a Key Informant (KI). Key informants were trained on how to take visual acuity, identify children with poor vision and any other ocular abnormalities, register and refer them to an agreed examination center.

Identification of children by Key Informants: Key informants identified children by moving from house to house, visited schools and received information from parent/caretakers on children with poor vision. For suspected children, KI took visual acuity using a 6 meter string and a 6/60 optotype E chart. Any child who could not see the 6/60 optotype at 6 meters was registered. Pre-verbal children who could not be tested using the E chart, but whose parents suspected that they had poor vision were also listed. Children were brought to the examination center by their parents/caretakers. At the agreed examination center, each KI presented the listed children for examination by an ophthalmologist and an optometrist.

Examination of identified children: A short history was taken to determine the demographic characteristics, age of onset and nature of the condition that led to SVI/BL. Presenting visual acuity of each eye was tested separately using the Illiterate Snellen chart at 6 meters. Children wearing spectacles were tested with spectacles on. Any child who could not see the 6/60 optotype on the E chart was enrolled for the study. For children not able to be tested using the E chart for various reasons, Cardif acuity cards were used employing the standard staircase method[10].

Other tests like ability to fixate and follow light were also employed to ensure whether the child could see or not. The anterior segment was examined using a magnifying loupe and torch. Cycloplegic refraction using a retinosope was performed where indicated. Indirect and direct ophthalmoscopy was performed to elicit signs and conditions affecting the posterior segment. Extraocular motility was performed to ascertain ocular alignment. Intraocular pressure was measured using iiCARE portable tonometer. Data was collected using the WHO/PBL form for childhood blindness and low vision[11]. All children needing further examination and treatment were referred to Mbeya Zonal Referral Hospital.

Causes of visual loss were classified according to WHO classification[11]. Anatomical site of abnormality was recorded for each eye and the main cause of visual loss determined. The underlying aetiology was determined based on history to establish time of onset, ocular and clinical findings as: hereditary, intrauterine, perinatal, and childhood factors according to WHO guidelines. A diagnosis for each patient as a cause of SVI was reached.

Data analysis

Data were analyzed using Statistical Package for Social Sciences (SPSS 20.0, Chicago, IL). Means were used for continuous data while categorical data are presented as percentages. Anatomical causes and diagnoses were presented as percentages out of the total number of SVI/BL children. Differences between proportions were ascertained using Chi squared test. A two-sided

p-value of less than 0.05 was considered statistically significant and 95% confidence intervals for prevalence were calculated assuming a normal approximation to the binomial distribution.

Ethical considerations

Approval to conduct the study was granted by the Research and Publication Committee of MUHAS. Permission to conduct the study in the district was given by the District Executive Secretary. Parents and caretakers consented for their children to take part in the study.

RESULTS

A total of 247 children with various eye conditions were identified by key informants, referred to examination centers and examined. Sixty six children with presenting vision of < 6/60 were enrolled for the study and were included in the analysis.

Seventy percent of children were aged five years or more with a mean age of 9.18 (standard deviation =4.42) years). There were slightly more females (53%) compared to males. Three quarters had severe visual impairment and slightly above a quarter (27.3%) were blind (Table 1).

Lens related conditions (27.3%) followed by uncorrected refractive error (15.2%) and corneal related disorders (13.6%) were the commonest causes of visual impairment/blindness among the study population (Table 2).

Table 1: Demographic and clinical characteristic of children with severe visual impairment/blindness (n=66)

Characteristic	No. (%)
Age (years)	
<5	20 (30)
5 - 15	46 (70)
Mean age (SD)	9.18 (4.42)
Sex	
Male	31 (47.0)
Female	35 (53.0)
Visual acuity categories	
<6/60-3/60	48 (72.7)
<3/60	18 (27.3)

Table 2: Anatomical causes of severe visual impairment and blindness

Cause	No. (%)
Lens related	18 (27.3)
Uncorrected refractive error	10 (15.2)
Corneal related	9 (13.6)
Squint and amblyopia	7 (10.6)
Cortical blindness	6 (9.1)
Optic atrophy	5 (7.6)
Congenital glaucoma	4 (6.1)
Retina	4 (6.1)
Whole globe	2 (3)
Uvea	1 (1.5)
Total	66 (100)

Table 3: Distribution of causes of severe visual impairment/blindness by age and sex

	Sex		Age group (years)		Total
Cause	Male	Female	<5	5-15	
Lens related	5 (27.8)	13 (72.2)	6 (33.3)	12 (66.7)	18 (100)
Refractive error	3 (30)	7 (70)	0 (0.0)	10 (100)	10 (100)
Corneal related	5 (55.6)	4 (44.4)	2 (25)	7 (75)	9 (100)
Squint and amblyopia	4 (57.1)	3 (42.9)	4 (57.1)	3 (42.9)	7 (100)
Cortical blindness	6 (100)	0 (0.0)	4 (66.7)	2 (33.3)	6 (100)
Optic atrophy	3 (66.6)	2 (33.7)	0 (0)	5 (100)	5 (100)
Congenital glaucoma	1 (25)	3 (75)	3 (75)	1 (25)	4 (100)
Retina	2 (50)	2 (50)	0 (0)	4 (100)	4 (100)
Whole globe	2 (100)	0 (0)	0 (0)	2 (100)	2 (100)
Uvea	0 (0)	1 (100)	1 (100)	0 (0)	1 (100)
Total	31(47)	35 (53)	20 (30)	46 (70)	66 (100)

The proportion of children with SVI/BL due to cataract, uncorrected refractive error and congenital glaucoma was higher among girls than boys while all children with cortical blindness were males. The proportion of lens related and cortical blindness conditions as causes of SVI/BL among under-five children was higher than that of older children (6/20, 30% vs 12/46, 26%) and (4/20, 20% vs 2/46, 4%). All children with refractive error, retina and optic nerve disorders were between 5-15 years while those with cortical blindness were aged less than 5 years.

Table 4: Diagnoses of conditions causing severe visual impairment and blindness

Anatomical cause	Diagnosis	No. (%)
Lens related	Cataract	14 (21.2)
	Pseudophakia with amblyopia	2 (3.0)
	Pseudophakia with PCO	2 (3.0)
Refractive error	Myopia (-4DS,-5DS)	2 (3.0)
	High myopia >6DS	3 (4.5)
	Mixed astigmatism	3 (4.5)
	Hyperopia	2 (3.0)
Corneal related	Corneal scar	4 (6.1)
	Phthisis bulbi	1 (1.5)
	Keratoconus	4 (6.0)
Squint	Squint with amblyopia	7 (10.6)
Cortical blindness	Cortical blindness	6 (9.0)
Optic nerve diseases	Optic neuropathy	2 (3.0)
	Primary optic atrophy	2 (3.0)
	Optic atrophy-brain tumour	1 (1.5)
Glaucoma	Congenital glaucoma TET done	1 (1.5)
	Congenital absolute glaucoma	1 (1.5)
	Congenital glaucoma	2 (3.0)
Whole globe	Congenital nystagmus	2 (3.0)
Retinal diseases	Macular scar/dystrophy	4 (6.0)
Uvea	Pan uveitis	1 (1.5)
Total		66 (100)

Un-operated cataract was the leading diagnosis causing visual impairment and blindness. Only 4 patients were operated for cataract. There was only one patient with phthisis bulbi related to keratomalasia (Table 4).

Table 5: Distribution of aetiological causes of severe visual impairment/blindness

Aetiological cause	No. (%)
Hereditary	2 (3.0)
Intrauterine	3 (4.5)
Perinatal	7 (10.6)
Childhood	19 (28.7)
Cannot determine	31 (52.8)
Total	66(100)

In 31 (47%) children, the aetiological cause of SVI/BL could not be determined while it was possible to determine in 34 (53%) children. Majority 19/31 (28%) of causes of SVI/BL occurred during childhood and included: refractive error (4), severe allergic kerato-conjunctivitis (2), developmental cataract (4), complicated cataract (1), optic atrophy (5), and keratoconus (3). Perinatal conditions included: neonatal conjunctivitis (2), cortical blindness (6) where 5 were blind since birth and one of them had cerebral palsy. Intrauterine factors included: congenital cataracts with probable congenital rubera syndrome in 3. Hereditary causes included: congenital cataracts with history of same condition in another sibling.

DISCUSSION

The study found lens related conditions (mainly un-operated cataract) as the leading anatomical cause of SVI/BL in Mbarali district keeping with other population based studies in developing countries[7, 8,12]. This finding is at variance with earlier studies especially those conducted in blind schools in Kenya, Uganda, Malawi [13, 14], Burundi[15] and one recent population based study in Uganda[16] where corneal pathology specifically corneal scarring, phthisis-bulbi was the leading anatomical cause of SVI/BL.

Cataract is a treatable cause of SVI/BL. Its prevalence increases where services for cataract surgery are inadequate leading to a backlog of cases as was seen in Bangladesh[12]. Majority (10/18, 56%) of cataracts in the current study were congenital and un-operated among older children more than 5 years of age. It is likely that these children have developed amblyopia and will not achieve maximum visual restoration due to increased age at and, delayed surgery[17].

The four operated children were still SVI/BL despite surgery due to post-operative complications like posterior capsular opacification and probable amblyopia related to poor follow up as was found in a study in Malawi[18]. There is no CEHTF to provide surgery for childhood cataract in the southern part of Tanzania. The few operated patients were probably operated on outreach basis and lacked proper follow up.

In contrast to studies involving children from blind schools in Africa[7, 8] and Asia[12] lens related conditions in the current study were commoner among females (10/14)

than males. The present study did not involve any children from blind schools as there were none in the district. It is possible that, boys with cataracts had been sent to schools outside the district leaving the girls behind.

Compared to results of a previous study in a neighbouring region of Dodoma where measles infection related corneal scarring was the leading cause of SVI/BL[3] there seems to be a change in the major causes SVI/BL in this population. The change is due to availability and accessibility of primary health services for children. Successful implementations of vitamin A supplementation and measles immunization have reduced corneal related SVI/BL in Tanzania. In the present study, corneal conditions as causes of SVI/BL were responsible for only 9(13.6%). Among them, there was only one child with phthisis bulbi that could be attributed to keratomalasia as a complication of measles infection.

The finding that uncorrected refractive error was another significant cause of SVI in this study was unexpected as a previous study[19] reported a very low prevalence among primary school children. Also, important to note is that 2 children were affected by the Tanzanian Endemic Optic Neuropathy indicating that the disease is prevalent even in areas outside Dar-es-Salaam and the coastal areas[20,21]. Retinopathy of Prematurity (ROP) was not among the diagnosed causes of SVI/BL in this study. This is probably due to the fact that highly premature babies may not be surviving to develop ROP. However future studies should also screen for ROP especially in big cities where small babies are now surviving.

In this survey, the mean age of children was 9.18(±4.42) years with three quarters of them being older than 5 years of age. Cataract was the leading cause of SVI/BL among under-fives similar to the study in Bangladesh[12]. The proportion of children with SVI/BL for every cause was higher among children aged 5 years and above except for cortical blindness where 80% of affected children were below 5 years. This finding may be explained by a cumulative effect of children affected by other causes of SVI/BL due to lack of services. A higher proportion of cortical blindness among under-fives may result from poor obstetric services in recent years related to birth asphyxia. Uncorrected refractive errors were a cause of SVI in older children probably due to the fact that refractive errors are known to increase with age in late childhood and adolescence[22].

All children with cortical blindness due to birth asphyxia were males. According to studies male fetus have a higher incidence of cord complications, fetal distress, labour dystocia, operative delivery and low apgar score[23,24]. In a resource constrained area, such complications lead to birth asphyxia and eventual cortical blindness in the affected child. Further research is recommended. In this study, most of the aetiological causes of SVI/BL were undetermined due to the difficulties of establishing the circumstance that led to the condition and timing of onset similar to other studies[7, 8, 12].

CONCLUSIONS

Lens related anomalies specifically un-operated cataract is the leading cause of SVI/BL in children in Mbarali district. Measles related corneal scarring is no longer an issue in this community. Cortical blindness was found among under-five male children while retinal diseases were prevalent in older children. Establishment of tertiary eye services to provide surgical, medical, optical, and low vision management to children in southern Tanzania is recommended. Strengthening of eye care services in the district are required to enable identification and referral of affected children to paediatric ophthalmology tertiary centers. Further studies to establish the cause of birth asphyxia with eventual cortical blindness among male children is also recommended.

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REFERENCES

1. Gilbert CE, Foster A. Childhood blindness in the context of VISION 2020-The right to Sight. *Bull World Health Org.* 2001; **79**(3):227-232.
2. Gilbert C, Foster A. Blindness in children: Control priorities and research opportunities. *Br J Ophthalmol.* 2001; **85**(9): 1025-1027.
3. Foster A, Sommer A. Corneal ulceration, measles, and childhood blindness in Tanzania. *Br J Ophthalmol.* 1987; **71**:331-343.
4. Muhit MA. Childhood cataract: Home to hospital. *Comm Eye Health*. 2004; **17**(50):19-22.
5. World Health Organization. Preventing blindness in children. WHO/PBL/00.77. WHO, Geneva, 1999.
6. Agarwal PK, Bowman R, Courtright P. Child eye health tertiary facilities in Africa. *J AAPOS*. 2010; **14**(3):263-266.
7. Kalua K, Ngongola R T, Mbewe F, Gilbert C. Using primary health care (PHC) workers and key informants for community based detection of blindness in children in Southern Malawi**.** *Human Resources for Health.* 2012; **10**:37. *http://www.human-resources-health.com/content/10/1/37/&*
8. Demissie BS, Solomon AW. Magnitude and causes of childhood blindness and severe visual impairment in Sekoru District, Southwest Ethiopia: a survey using the key informant method. *Trans R Soc Trop Med Hyg.* 2011; **105** (9):507-511.
9. Omolase CO, Aina AS, Omolase BO, *et al*. Causes of blindness and visual impairment at the school for the blind Owo, Nigeria**.** *Annals Ibadan Postgraduate Med.* 2008; **6**(1): 49-52.

10. Adoh TO, Woodhouse JM. The Cardiff acuity test used for measuring visual acuity development in toddlers. *Vision Res*. 1994; **34**(4):555-560.
11. Gilbert C, Foster A, Negrel AD, *et al*. Childhood blindness: a new form for recording causes of visual loss in children. *Bull World Health Org*. 1993; **71**(5):485 - 489.
12. Muhit, MA, Shah SP, Gilbert CE, Foster A. Causes of severe visual impairment and blindness in Bangladesh: a study of 1935 children. *Br J Ophthalmol.* 2007; **91**:1000 -1004.
13. Njuguna M, Msukwa G, Shilio B, Tumwesigye PC, Courtright P. Causes of severe visual impairment and blindness in children in schools for the blind in eastern Africa: changes in the last 14 years. *Ophthalmic Epidemiol*. 2009; **16**(3):151-155.
14. Gilbert CE, Wood M, Waddel K, Foster A. Causes of childhood blindness in East Africa: results in 491 pupils attending 17 schools for the blind in Malawi, Kenya and Uganda. *Ophthalmic Epidemiol.* 1995; **2**(2):77-84.
15. Ruhagaze P, Njuguna KKM, Kandeke L, Courtright P. Blindness and severe visual impairment in pupils at schools for the blind in Burundi. *Middle East Afr J Ophthalmol*. 2013; **20**(1):61-65.
16. Arunga S, Onyango J, Ruvuma S, Twinamasiko A. Prevalence and causes of blindness and severe visual impairment (BL/SVI) among children in Ntungamo district, southwestern Uganda: a key informant cross-sectional population survey. *J Ophthalmol East Cent & S Afr.* 2016; **20**(1): 26-32.
17. Gogate DP, Ramsonet P, *et al*. Surgery for sight: outcomes of congenital and developmental cataracts operated in Durban, South Africa. *Eye.* 2016; **30**: 406–412.
18. Msukwa G, Njuguna M, Tumwesigye C, Shilio B, Courtright P, Lewallen S. Cataract in children attending schools for the blind and resource centers in eastern Africa. *Ophthalmology.* 2009; **116**(5):1009-12.
19. Wedner SH, Ross DA, Balira R, Kaji L, Foster A. Prevalence of eye diseases in primary school children in a rural area of Tanzania**.** *Br J Ophthalmol.* 2000; **84**:1291–1297. http://bjo.bmj.com/ on November 11, 2016
20. Kisimbi J, Shalchi Z, Omar A, *et al.* Macular spectral domain optical coherence tomography findings in Tanzanian endemic optic neuropathy**.** *Brain.* 3418 – 3426. DOI: http://dx.doi.org/10.1093/brain/awt221
21. Hodson KE, Bowman RJ, Mafwiri M, Wood M, Mhoro V, Cox SE. Low folate status and indoor pollution are risk factors for endemic optic neuropathy in Tanzania**.** *Br J Ophthalmol.* 2011; **95**(10):1361-4. doi: 10.1136/bjo.2010.197608. Epub 2011 Jul 6.
22. Flitcroft DI. Emmetropisation and the aetiology of refractive errors. *Eye*. 2014; **28**: 169 -179.
23. Laura A, Alberto P, Mercedes V, Paz CM, Francisco M. Fetal sex and perinatal outcomes. *J Perinat Med*. 2012; **40**(3):271–276.
24. Viegas OA, Lee PS, Lim KJ, Ravichandran J**.** Male fetuses are associated with increased risk for cesarean delivery in Malaysian nulliparae. *Medscape J Med.* 2008; **10**(12):276. [PMC free article] [PubMed])