Original Article

Vision Screening of Learners by Teachers in Kafue District in Zambia as a Strategy to Address the Challenges of Childhood Blindness

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ABSTRACT

Background: Early detection and treatment of eye diseases in children is critical in combating childhood blindness. Innovative community-based strategies such as training of teachers in vision screening need to be developed for effective utilisation of the available human resources as well as to counter the challenges of inequitable distribution of trained eye health human resources as well as the limited access of quality eye health care services to the majority of our population.

Aim: To evaluate the effectiveness of using teachers as the first level of vision screeners.

Materials and Methods: Teacher training programmes were conducted for schoolteachers to educate them about childhood eye diseases and the significance of their early detection. The teachers trained for the school vision screening were from all government, private and community schools located in Kafue District. The teachers then conducted vision screening of learners in their schools. Subsequently, the mobile eye health teams visited the schools for the re-evaluation of learners identified with poor vision. All learners identified with refractive errors had refraction performed on them and spectacles prescribed. The mobile eye health teams referred learners requiring a further ophthalmic evaluation to the University Teaching Hospitals – Eye Hospital which was the base hospital for the programme. The assessment included calculation of true positives, false positives, true negatives and false negatives.

Results: One hundred and fifty-four (154) teachers from 73 primary and secondary schools underwent training in vision screening. The teachers screened 18,713 learners and reported eye diseases in 2,818

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(15.1%) children. However, the mobile eye health teams examined 5,958 learners who included 2,818 referrals from teachers and 3,140 rescreened learners. The mobile eye health teams confirmed eye problems in 2,818 learners screened by the teachers and further diagnosed more eye problems in 999 learners giving a total of 3,817 learners with eye problems. Thus, the teachers were able to correctly identify eye problems (true positives) in 100.0% (2,818/2,818) of learners. The teachers could not identify eye problems in 999 learners giving false negatives were 26.2% (999/3,817).

Conclusion: Considering the high true positive value and the comprehensive coverage provided by the survey, vision screening in schools by teachers is an effective method of identifying learners with eye problems and poor vision early. This strategy could be valuable in reducing the workload of the eye health care staff.

INTRODUCTION

Visual Acuity (VA) is very important for educational and behavioural development of children from an early age.[1] Eye health care policy is vital in promoting school eye health programmes and screening of eye problems.[1] The eye health care policy is also an imperative requirement in combating childhood blindness. Central to these eye health programmes should be some form of VA screening designed to detect refractive errors and other ocular disorders. The Visual Acuity screening programmes have been a central component of the World Health Organization's Vision 2020 goals in most of the developing world.[2] Control of childhood blindness has been one of the priorities of the World Health Organization's "VISION 2020 — The Right to Sight programme".[3] There are several reasons for this. Firstly, the children who are born blind or who become blind during childhood have a much higher number of blind years than an adult who becomes blind later on. Secondly, many of the causes of blindness in children are either preventable or treatable. Uncorrected vision problems in children can worsen over time and result in permanent loss of vision. Thirdly, many of the causes of childhood blindness are also associated with child mortality (such as premature birth, measles, congenital rubella, vitamin A deficiency, and meningitis). Thus, timely detection of these conditions can contribute to higher chances of child survival.[3]

A school-based VA screening programme is substantially more effective and less costly for delivering eye health care to learners (school-going children).[4] Due to the scarcity of ophthalmic professionals, especially Ophthalmologists and Optometrists, in almost all low and middle-income settings, school screening programmes have been modelled around non-eye health care personnel; most commonly school teachers and occasionally school nurses who are trained to conduct the VA testing.[5]

Childhood blindness can hinder education, personality development and limit career opportunities, in addition to causing an economic burden on society. Childhood blindness due to various avoidable and treatable causes in any population suggests that eye health care services in that population are inadequate.[6] For all these reasons, effective strategies must be developed to eliminate avoidable and treatable causes of childhood blindness. Strategies to address the eye health of children during the early years of life could, therefore, be focused on school screening eye health programmes.

Vision screening of learners (children in schools) has traditionally been done by ophthalmic assistants, Optometrists and Ophthalmologists. There is a massive deficit of trained eye health care personnel. There is one Ophthalmologist per 1,100,000 population in Zambia. Similarly, there is one ophthalmic assistant per 300,000 population (NEHSP 2017-2021).[7] Significant proportions of the rural populations do not have access to quality eye care services as most Ophthalmologists are concentrated in urban areas.[8]

Taking these aspects into consideration, innovative community-based strategies are required to provide quality services to the underserved sections of the community. Capacitating teachers in screening for eye problems in schools, especially in rural areas, can result in early detection of potentially blinding disorders in children and thereby effective utilisation of existing human resources. Involving teachers in vision screening can save an enormous amount of time and energy of the eye health care staff, reduce their workload and provide broader coverage of eye health care services. We present here our experience of vision screening of the school children by their teachers, thus exploring the possibility of introducing teachers as the first level vision screeners to eliminate childhood blindness in Zambia.

MATERIALS AND METHODS

The programme of vision screening of learners (school-going children) by their teachers was conducted by joint effort of the Ministries of Health and General Education with the support of Vision Aid Overseas (VAO). Seventy-Three (73) primary and secondary schools in the Kafue district, were covered in this programme. These schools were private, and government run. The list of the schools was obtained from the District Education Board Secretary (DEBS), and all the schools were selected to participate in the programme. Permission to conduct the vision screening in the schools was obtained from the Permanent Secretaries of both Ministries of General Education and Health. The Head Teacher of each school was requested to nominate at least two teacher and schools with a high number of learners could nominate up to four teachers for training in VA testing and eye health screening. The selected teachers underwent a teacher training programme organised by the Ministries of Health and General Education in collaboration with VAO. The teachers underwent a one-day training programme which was conducted in several sessions and according to the sizes of the schools, location and the zones in which they were located. The number of teachers per training session varied from four to eight.

The training was in form of lectures covering topics on the magnitude of childhood blindness, the importance of early detection of eye problems in children, the role of teachers in early detection of childhood eye diseases and methodology of vision screening of learners by their teachers in the schools. The practical sessions were given by trained eye health personnel where the process of vision assessment was demonstrated, and the steps involved explained in detail. To ensure learning had taken place, each teacher had to repeat the whole procedure in front of the health worker staff and an opportunity was given to them to ask questions. After the training they were all provided with basic kits containing a VA screening chart, six-metre measuring tape, a pen torch, an eye occluder and forms (Table 1) to be completed after vision screening of the learners. Some educational materials were also provided.

Table 1: Teacher Screening Form (Form A)

Ministry of Health														
District Name:									Name of School:					
Teacher's name:									School EMIS code:					
Teacher's signature:									Grade:					
Teacher's phone number:									Date:					
					Distance Vision Right Eye		Distance Vision Left Eye		Eye Health Exam Right Eye		Eye Health Exam Left Eye		Referral	Remarks
.	Class	Name	Age	Gender (M/F)	Pass	Fail	Pass	Fail	Pass	Fail	Pass	Fail	Yes/No	Reasons for referral (Record symptoms for reference here)

The vision screening chart was white in colour, with four black 'E' optotypes of a size equivalent to 6/9 of the Snellen's visual acuity chart. The chart had to be read at a distance of six metres in daylight illumination. The height of hanging the chart was adjusted according to the height of the learner/child. Each eye had to be tested individually. For each eye, the child had to indicate the direction of the open end of the 'E'.

If the child identified all the four 'E' optotypes correctly with each eye, he/she was labelled as 'normal' and having passed the VA test. If anyone of the four 'E' optotypes was incorrectly identified by either of the eyes, the child was labelled as 'poor vision' and was considered to have failed the VA test.

The teachers were given a period of 7-21 days to conduct vision screening of all the learners randomly picked in their respective schools. Teachers recorded the data in the form which included name, age, gender and the visual status (pass (normal) or fail (low vision)) of all the learners screened on form A, Table 1. The detailed data of learners identified as having failed the VA test by the teachers was recorded on form B, Table 2. The learners who had obvious ocular pathologies were also recorded and booked for the mobile eye clinics.

Table 2: Learner Failed VA Data (Form B)

Name of District: ……..	Name of Child: …………….
Name of School:………..	Sex: Male [ ] Female [ ]
EMIS Code:……………..	Date of Birth: ………………
Name of Teacher: ……..	Age in Years: ………….….....
Date of Screening: ….....	Grade: …………………...….
	Phone ? of Parent/guardian:...

The parents of the learners who failed the VA test were notified on the date of the visit by the mobile eye health teams to the school by sending the message through the learners. Subsequently the mobile eye health teams from the Ministry of Health who included Ophthalmologists and Ophthalmic Nurses visited all the schools on the scheduled dates. All the learners identified as having failed the VA test by the teachers were re-examined by the mobile eye health teams. The eye examination included the recording of visual acuity using standard Snellen's visual acuity chart,[9] torchlight examination and fundus examination with direct ophthalmoscope.[10]

Table 3: Learner data form from the mobile eye health teams' evaluation (Form C)

TO BE FILLED OUT BY TRAINED EYE HEALTH PROFESSIONAL		
	RE	**LE**
1. Visual Acuity		
REFRACTION		
	Yes	**No**
1. Does the child have a refractive error?		
2. Was refraction done?		
3. Where spectacles needed (diagnosed)?		
4. Where spectacles prescribed?		
	Right Eye	**Left Eye**
5. What is the power of lenses needed per eye?		
	Yes	**No**
6. Where spectacles ordered?		
7. Where spectacles dispensed on-site?		
8. What was the refractive error type?		
	Yes	**No**
9. Was the child referred for further treatment?		
10. Did the child go for further treatment?		

The data regarding the visual status of the learners was recorded on form C by the mobile eye health teams. The complete data included the VA of the learner/child and the cause of visual impairment in that learner. Refraction was performed, spectacles prescribed and for straightforward cases dispensed within the school premises. Treatment for certain eye diseases was administered right there and then. A learner who required further evaluation was referred to the base hospital, the University Teaching Hospitals–Eye Hospital.

Learners identified with abnormalities by the teacher and confirmed to have abnormalities by the mobile eye health teams were considered as true positives, Figure 1. Learners identified with abnormalities by the teacher but proved to have no abnormality by the ophthalmology teams were considered as false positives. Learners identified as normal by the teacher but found to have defects by the mobile eye health teams were considered as false negatives, Figure 1. Leaners identified as normal by the teacher and confirmed to have no abnormality by the ophthalmology teams were considered as true negatives.

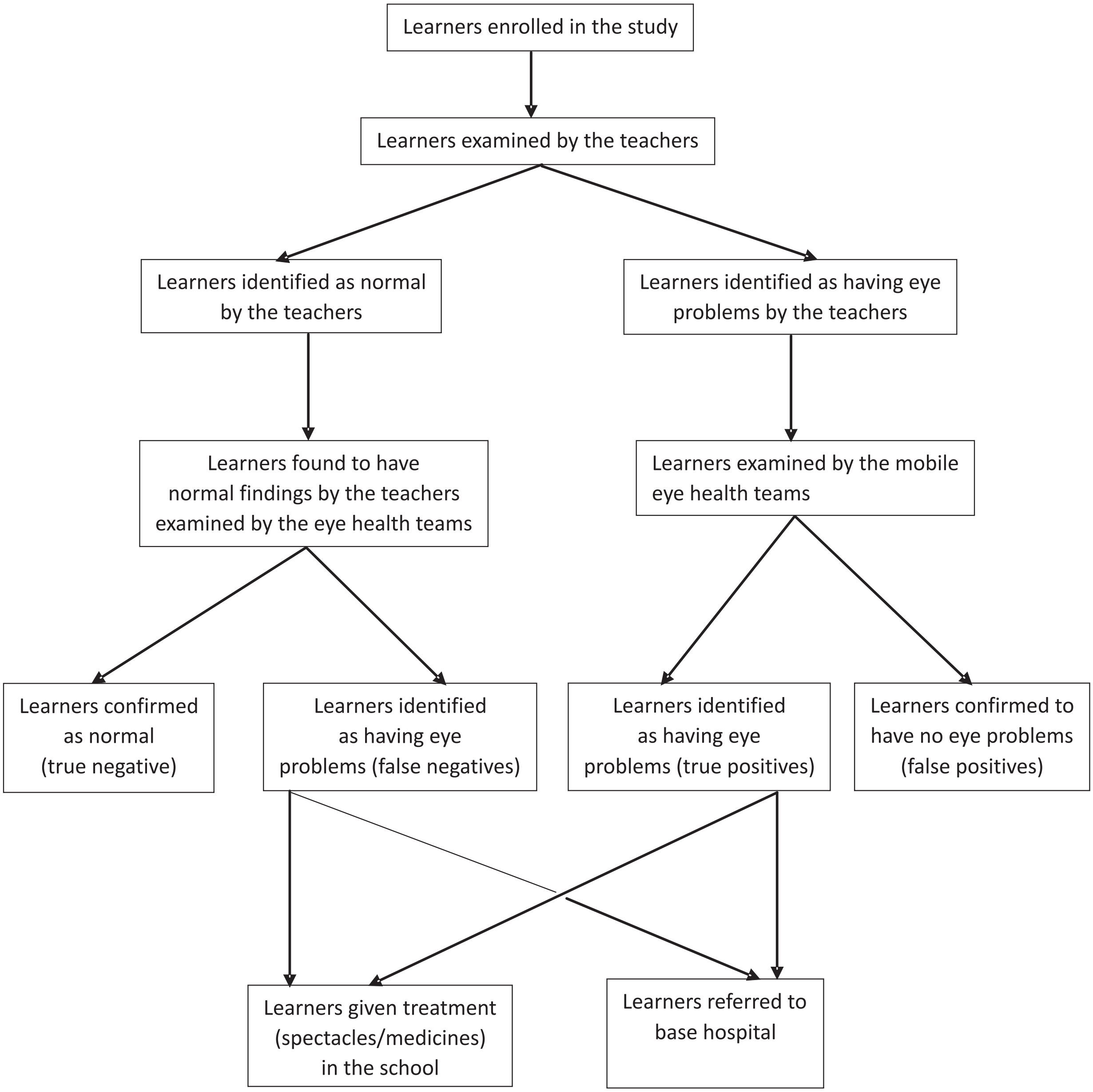

Figure 1: Flowchart representing the methodology used in conducting the eye school screening

The definition of the schools and learners being rural or urban was based on the categorisation already in place by Kafue District Education Board. All the schools that are located more than 37 kilometres from the Kafue District Education Board offices are categorised as rural schools. The schools found within the radius of 37 kilometres are urban schools.

The data from the forms A and B received from each school was entered into a computer in an MS-Office Excel worksheet and was analysed using the IBM Statistical Package for Social Scientists (SPSS) version 26. Data on true positives and false positives were derived from the group of the leaners identified as having poor vision by the teacher. Data on true negatives and false negatives was derived from the group of the learners identified as normal by the teachers. The final data was analysed to assess the effectiveness of the method of vision screening of learners by teachers.

Also, a data analysis regarding the percentage of various causes of visual impairment in the learners screened in these schools was done.

RESULTS

Kafue District had a total of 73 schools and 43,370 learners. These schools and learners were distributed as 34 primary schools with a total of 28,823 learners, ten secondary schools with a total of 6,215 learners, 11 private schools with a total of 2,958 learners and 18 community schools with a total of 5,374 learners. In the survey, all the 73 schools in Kafue District were included. A total of 154 teachers from the schools were trained in vision screening through teacher's training programme. The survey enrolled 18,713 learners. Out of these, 10,105 (54.0%) were females and 8,608 (46.0%) males, Figure 2 below. The male to female ratio was 1:1.17

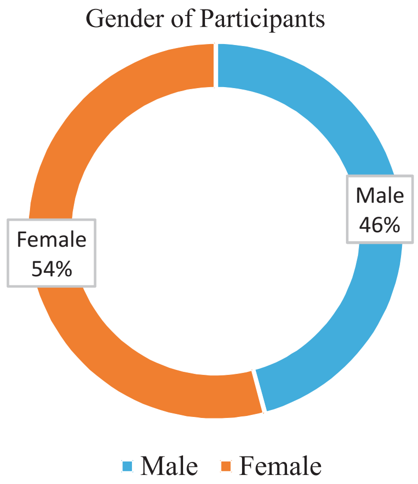

Figure 2: Gender of Participants

The teachers were able to screen 18,713 learners out of 43,370 learners enrolled in Kafue District, thus providing coverage of 43.1%. The 18,713 learners included 8,608 (46.0%) males and 10,105 (54.0%) females. The learners' age ranged from 3 years to 26 years, with a median age being 12 years. Most of the participants were over 13 years 6,342 (33.9%) followed by 11-13 age group 5,560 (29.7%) then 8-10 years age group 5,150 (27.5%) and seven years and less who were 1,661 (8.9%) as shown in Figure 3.

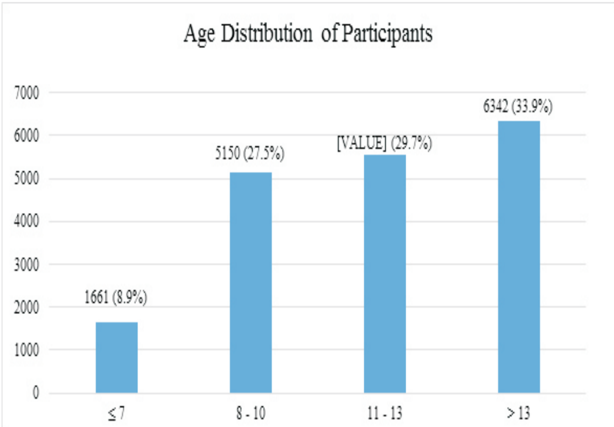

Figure 3: Age Distribution of Participants

The survey had more learners who were rural dwellers than urban ones, Figure 4.

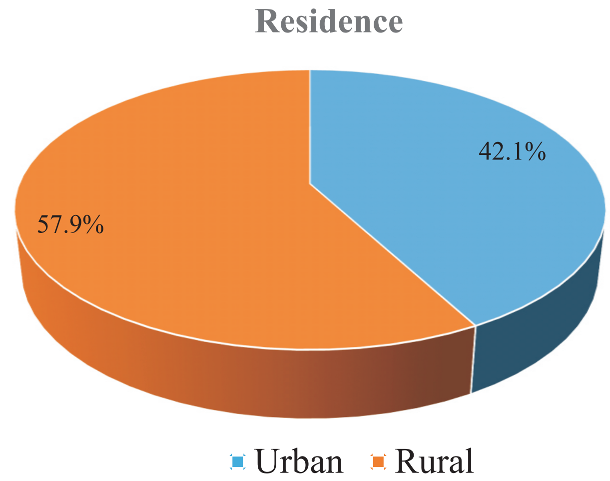

Figure 4: Distribution of Learners according to residence

Out of 18,713 learners who were screened by the teachers, 2,818 learners were identified with eye problems and needed evaluation by mobile eye health teams. Considering that the 2,818 learners identified by the teachers to have eye problems was 15.1% of all the learners enrolled for the programme, the Ophthalmologists and the mobile eye health teams considered re-examining another 15.1% of the learners identified as normal by the teachers. This led to an additional 3,140 learners examined, totalling 5,958 learners examined by the Ophthalmologists and the mobile eye health teams. The 3,140 learners were randomly selected from the learners identified as normal by the teachers. This was done for programme validation. Of the 5958 learners screened by the mobile eye health teams, 3817 were found with eye problems including refractive errors while 68 were referred for further evaluation and management at the University Teaching Hospitals – Eye Hospital (UTHs-EH), Table 4. The mobile eye health teams were able to examine and confirmed eye problems in 100.0% of the learners identified to have eye problems by the teachers. The true positives were therefore 100.0% (2,818/2,818).

Table 4: Screening by Teachers and Eye Health Personnel

Category	Number of Learners
Total number of learners screened by teachers	18,713
Learners identified with eye problems by teachers	2,818
Total number of learners examined by the mobile eye health teams	5,958
Learners identified with eye problems by after confirmatory screening by the mobile eye health teams	3,817
Learners referred to the base hospital (UTHs-EH)	68

Of the 3,817 learners identified with eye problems, 73.8% (2,818/3,817) were those identified by the teachers which gave the rate of true positives at 100% while 26.2% (999/3,817) were the additional learners identified by the mobile eye health teams which also made up false negatives, Figure 4. Of the 3,140 extra learners attended to by the mobile eye health teams, 2,141 had normal findings giving the true negatives at 68.2% (2,141/3,140). Out of the 2,818 learners/children identified as true positives, 2,269 (80.5%) were diagnosed to have allergic conjunctivitis, 16.3% refractive errors, 0.4% strabismus, 0.2% amblyopia and 0.6% had paediatric cataract (Table 5).

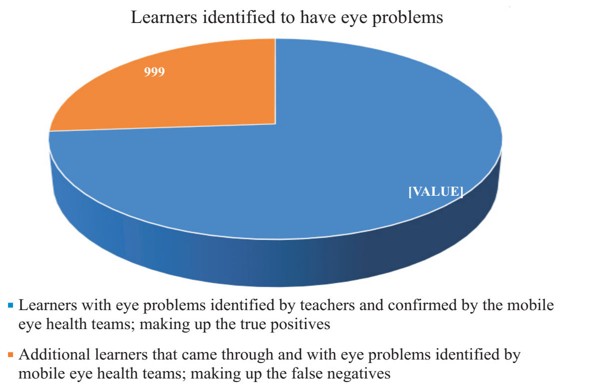

Figure 4: Learners identified to have eye problems by the teachers and and extra the by mobile eye health teams

The eye conditions identified among the learners ranged from refractive errors, allergic conjunctivitis and amblyopia among others, Table 5.

EYE CONDITIONS IDENTIFIED	NUMBER OF LEARNERS	PERCENTAGES
Refractive errors	621	16.3%
Allergic conjunctivitis	3,073	80.5%
Cataracts	23	0.6%
Cornea scars	14	0.37%
Amblyopia	8	0.21%
Strabismus	15	0.39%
Retina disorders	2	0.05%
Others	61	1.6%
Total	3,817	100%

Table 5: Eye Conditions Identified during School Screening

The mobile eye health teams examined all the 2,818 learners as they were all present on the day of the visit by the eye health teams. The eye health teams confirmed eye problems in 2,818 learners. Spectacles were prescribed to 621 learners/children in their schools, out of which all the spectacles were given free of cost to the children. A total of 68 children were referred to the base hospital (UTHs-EH) for further evaluation and management.

DISCUSSION

Kafue District was the location for the eye school screening survey. This school eye screening programme was the largest performed in Zambia. It was conducted by Teachers, Ophthalmic Nurses and Ophthalmologists. The primary eye health care providers were substituted by 154 School Teachers to do the initial vision screening of the learners in the schools.

The Teachers were able to screen 18,713 learners out of 43,370 learners enrolled, thus providing coverage of 43.1%. The benchmarks to monitor and evaluate the school eye screening were considered as given by Limburg et al., 1999.[8] The coverage benchmark is 80-100% which indicates the ability of the institution to organise the programme.

Limburg et al. 1999, suggested that if the number of children examined by the ophthalmic personnel is less than 50% of those referred, the referral system needs to be checked.[8] In our programme, the mobile eye health teams was able to examine 100.0% of the learners detected with eye problems by their teachers and referred for ophthalmic evaluation which was a positive achievement.

The proportion of learners screened, those referred for an ophthalmic evaluation and the proportion of learners' spectacles prescribed is an indicator of the quality of screening by the teachers.[8] These parameters are indirect indicators of the quality of the training of the teachers in vision screening. Limburg et al. 1999, suggested that the referral rates outside 5-10% and spectacle prescription rates less than 40% indicate the need to evaluate the training of the teachers.[8] In our survey, the proportion of learners referred to the mobile ophthalmic evaluation was 15.1%, and the proportion of learners prescribed spectacles 3.3%. This was lower than the benchmarks proposed by Limburg et al.[8] By the suggestion of Limburg et al. this may indicate that the training of teachers may need to be re-evaluated and modified to make them more confident. However, it can be argued that the benchmark set by Limburg et al., may not be applicable in certain settings such as the Kafue one due to the low numbers of refractive errors that may naturally be found in such an environment where studies have not been conducted as such more studies may need to be conducted to come up with a range of benchmarks. Also, the fact that 3,073 learners were confirmed to have allergic conjunctivitis of varying severity, is an indicator of the effectiveness of not only the teacher training, but also the screening by teachers.

The proportion of learners referred to the base hospital indicates the confidence of the mobile eye health teams. In this survey this was 2.1% against a benchmark of 10-20%.[8] Again, this could have just been an assumption by Limburg et al. The confidence of the mobile eye health teams also depends on the composition and experience of the mobile eye health teams' members as well as the eye conditions encountered during the screening. In this survey, the mobile eye health teams composed of very highly experienced Ophthalmic Nurses and the Ophthalmologists were very active on the ground making sure only cases that needed tertiary level eye health care including custom made spectacles were referred for hospital ophthalmic management. The goal of the school screening was to identify learners with eye problems from their schools and to screen them thoroughly so that the referrals were as minimal as possible.

This approach made the school screening very relevant as the learners were helped right there and then. This was also conducted with the full realisation that when there are a lot of learners referred, there is no guarantee that all of them will go to the hospital even when the logistics will be provided for them. The way this survey was conducted, fitted well in the Zambian health vision of bringing health services as close to the family as possible.

The effectiveness of the school screening programme was assessed by the true positives, false positives, true negatives and false negatives. In the survey, 100.0% of learners were identified as true positives, and 26.2% were identified as false negatives. Thus, the positive predictive value of the survey was 100.0%. The false-positive rate is crucial as it is a measure of over-diagnosis/over-referrals by the teachers. Over-diagnosis and over-referrals mean that the mobile eye health teams must additionally screen these children when actually they do not need any screening. In this survey, there was no over-diagnosis and over-referral. The false-negative rate is crucial as it indicates the number of learners with eye problems missed by the teachers, which in turn reflects the quality of training for the teachers. School eye screening programmes should aim for a low false-negative rate as this may be the only chance for many of these children to undergo an eye examination and be picked up if having a problem. Thus, in any school screening programme, high false-positive rates may be acceptable, but a high false-negative rate is not at all acceptable. The study had 26.2% false negatives which were beyond acceptable levels. The high false-negative rate implied that teachers needed to be thoroughly trained on accurate identification of learners with eye problems.

The high false negatives indirectly increase the time and cost involved in the screening programme. This may also increase the anxiety of the learners (who have been falsely labelled as having no eye problems) and their caretakers reducing their confidence in the programme. Thus, reducing the false negatives would reduce the workload on the mobile eye health teams and reduce the cost of the screening programme. The high false negative rate in our study indicates that the teachers under-diagnosed in nearly half of the learners which also means that nearly half of the children examined by the teachers were unnecessarily re-examined by the mobile eye health teams. The high false negative rates could be because the teachers were either too cautious or too casual or indeed too overburdened in vision screening and labelled the learner as having no eye problem whenever they (teachers) were in doubt.

This can be rectified by improving the quality of training given to the teachers, thus making them more confident. The rectification could also be brought in by increasing the number of teachers to screen learners in relation to the number of learners. The under-diagnosis by the teachers, may not be acceptable because the learners could be denied the only chance, they could have to undergo an eye examination and be picked up if having a problem. Another method to reduce the false negatives is by using the 6/12 vision level as cut off instead of 6/9. Saxena et al., in their study showed that there was 44.6% reduction in total referral to the optometrist by using 6/12 as the cut off vision level.[11] The mobile eye health teams identified 2,141 (68.2%) out of

3,140 as true negatives. Thus, the negative predictive value of this survey was as high as 68.2% which was a good indicator of the effectiveness of the Kafue District eye school screening programme.

There may be a much-voiced concern that the school screening programme may increase the workload of the teachers and may interfere in their primary responsibility of teaching. In our survey, on average, each teacher screened 119 learners in the survey period and referred 18 learners/children for further examination by the mobile eye health teams. Presuming that it took five minutes to screen a child, each teacher is estimated to have spent 9-10 hours in a year to screen learners with an additional eight hours spent for training. This amounts to not more than 17-18 hours in a year. On the other hand, the workload of the Ophthalmologist and his teams is reduced significantly. In our survey, the Ophthalmologists examined 27.5% of the total learners enrolled for the survey. Use of trained health workers[8,12] and Teachers[11,13] as an alternative to Ophthalmologists has been recommended in previous studies and benefits clearly outlined.[8,11,12,13] The findings of our survey are similar to the observations of studies conducted by other researchers and reinforces the fact that there are substantial benefits of introducing teachers as first-level vision screeners followed by a mobile eye health teams comprising midlevel eye health workers.[11,13]

CONCLUSION

Utilising the services of the Teachers for vision screening of the learners in their schools significantly helps in early identification of learners with eye problems and reducing the workload for the eye health care personnel. Despite the observation that almost a third of learners were missed by the teachers in this survey it can be clearly demonstrated that the teachers can effectively perform vision screening of learners and refer those with eye problems.

Taking into consideration the benefits of this programme, simplicity of the procedure, the ease of its application and the wider coverage provided, it can be concluded that introducing teachers as primary vision screeners in their schools is an innovative community-based strategy to address the challenges of childhood blindness.

STUDY LIMITATIONS

The only drawback of this method of vision screening is that children who are not able to enrol in school and those learners who were absent from class on the day of screening would be left out.

RECOMMENDATIONS

A study is needed to look at factors associated with the high prevalence of allergic conjunctivitis amongst learners in Kafue District.

The school screening programme must be scaled up to the whole country in order to bring eye services closer to majority of the children who are enrolled in school throughout the country.

A strategy should be found to reach children who may not be enrolled in schools.

A constant ratio of the number of learners to be screened by the teacher in relation to the number of learners must be developed.

There is need for integration of eye health school screening programme into the School Health and Nutrition Programme under the Ministry of General Education.

The protocol for school screening needs to be made more relevant and appropriate for eye school screening in Zambia.

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