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Outcome of vision screening by community health workers at immunization outlets in Nigeria to support access to early visual evaluation in children aged 0–2 years

Dupe S. Ademola-Popoola[1]*, Victoria A. Olatunji[2], Tokunbo S. Obajolowo[2], Tanimola M. Akande[3], Olugbenga A. Mokuolu[4]

Abstract:

PURPOSE: Routine eye examination in early life is not the practice in most resource-limited countries. Delay in the presentation for eye problems is typical. Community health officers are often consulted by caregivers for all health problems during routine immunization and well-baby clinics in primary healthcare for children aged 0–2 years. This study evaluated the value and limitation of interview, Bruckner red reflex test, and instrument vision screener by noneye care middle-level staff of rural and urban well-baby immunization clinics, in early detection and referral for childhood eye disorders.

MATERIALS AND METHODS: This was a cross-sectional study. Middle-level community health workers (CHWs) working at well-baby/ immunization clinics were trained to perform vision screening using interview of caregivers, red reflex eye examination with ophthalmoscope, and instrument vision screener (Welch Allyn SPOT™ Vision Screener) without mydriatic drugs during routine immunization of children aged 0–2 years. IRB approval was obtained.

RESULTS: Over a 6-month period in 2017, the CHWs screened 5609 children. Overall, 628 (11.2%) patients were referred to the tertiary child eye care unit. Referred cases included cataract, glaucoma, congenital nasolacrimal duct obstruction, ophthalmia neonatorum, retinoblastoma, and significant refractive errors. Referral from the interview of mothers was enhanced if specific questions to elicit visual function were asked. Bruckner red reflex test was more effective than instrument vision screener in the detection of cataract and life-threatening diseases such as retinoblastoma. Instrument vision screener was preferred by parents and better at detecting amblyopic risk factors.

CONCLUSION: Preschool vision screening during routine immunization by primary healthcare workers in resource-limited settings was effective. Whenever instrument vision screener does not give any recommendation during screening, consider vision- or life-threatening pathology and refer.

Keywords:

Bruckner test, community health workers, instrument vision screener, interview, preschool vision screening

[1]Department of Ophthalmology, University of Ilorin Teaching Hospital, University of Ilorin, [2]Department of Ophthalmology, University of Ilorin Teaching Hospital, Departments of [3]Community Health and [4]Pediatrics and Child Health, University of Ilorin Teaching Hospital, University of Ilorin, Ilorin, Nigeria

***Address for correspondence:**
Dr. Dupe S. Ademola-Popoola, Department of Ophthalmology, University of Ilorin Teaching Hospital, University of Ilorin, P.O. Box 4718, Ilorin, Kwara State, Nigeria.
E-mail: dupsyp@yahoo.com

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Introduction

In early childhood, the role of vision in the development, the critical period for optimal visual outcome from intervention, and the concept of "blind year" are well established. Optimal visual outcomes from the treatment of childhood eye disorders are best achieved by early intervention, and it has been reported that amblyopia

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may lead to a significant increase in the risk of severe visual impairment or blindness in the event of vision loss in the nonamblyopic eye.[1-3] Abnormalities in the vision of young children could lead to suboptimal school performance and quality of life.[4]

Vision screening in childhood allows detection and treatment of vision abnormalities during the critical stage of development, when it can be most effectively treated for optimal outcome. Previous studies reported that preschool screening programs reduce the incidence of vision disorders.[5] Contrary reports are also available.[6-8]

Most child eye screening programs in different countries are targeted at children from the age of 3 years. Screening in better developed countries is mainly to detect amblyopia because other more obvious causes of visual impairment/blindness will be presented early enough by the parents.[6,9] The case is different in developing countries, because of social, economic, and cultural issues that may impede detection, as well as early presentation of obvious eye conditions, including retinoblastoma, strabismus, and cataract, which are often taken for granted by the caregivers. Strategies deployed for preschool screening in such regions must be simple, yet comprehensive, and effective to detect the obvious, potential vision-threatening conditions and amblyopic risk factors.

The components of screening programs in different countries vary widely in terms of screening criteria, tools, and personnel used. Photo screening devices use optical images (photographs) of the eye's red reflex to identify the risk factors in both eyes. Most photo screeners can estimate refractive error, media opacity, and ocular alignment. Interpretation of the image is based on the preestablished criteria; older devices require a trained interpreter, but newer machines often include computerized interpretation. Image acquisition takes a few seconds and captures both eyes at once, making them especially useful for preverbal or developmentally delayed children.

Autorefractors are computerized instruments that provide objective refractive status by measuring how light changes as it enters and reflects off the back of the eye. They are easy to use and fast.[10]

Potential explanations provided for better outcomes of early eye screening include greater effectiveness of treatment due to age-dependent plasticity, referral at an earlier stage in the course of the visual defect, greater adherence to treatment at that age range, and perceptual learning due to repeated testing.[11]

In Nigeria, children aged 0–5 years constitute about 17.1% of the population, being about 523,470 cases in Kwara State[12] where there is a law ("Kwara State Childhood Sight Protection Law 2013") that prescribes vision screening for children at different ages.[13] As at the time of starting this project in 2017, routine newborn/child eye screening program as part of wellness check was nonexistent.

Well-established and patronized scheduled routine childhood immunization and well-baby clinic services are provided for 0–2-year-old kids at primary care health centers by middle-level community health workers (CHWs). The CHWs are trained to provide basic health services at the primary care centers where there are no nurses or physicians; this serves to bridge the gap between the community and secondary/tertiary health facilities. In the well-baby clinic, they provide services such as health education to caregivers, immunization according to the national immunization schedule, as well as nutrition support program for children in the first 2 years of life. They also conduct home and community visits. Typically, CHWs have postsecondary training in a government-accredited institution lasting for between 2 and 3 years. They typically use standing order documents to provide specific health services.[14,15]

Although the CHWs have little or no training in eye health problems, they are often consulted early by mothers/caregivers when childhood eye/visual concerns are noticed. In some cases of leukocoria from cataract and retinoblastoma, lack of awareness about childhood eye problems by this category of staff made them to give counsel that children will outgrow eye problems and advise mothers not to worry when they expressed concerns about children's eye and visual functions.

This was identified as a major contribution to delay in the presentation and treatment of children in child eye units across Nigeria. Deliberate child eye health promotion was set up through task shifting, using existing personnel and services in well-baby clinics at primary health centers. This was used to achieve early detection of all types of child eye health problems, and referral to the tertiary child eye unit for early cost-effective intervention.

Methods

A program of continuum of care was established in 2017 for childhood visual impairment/blindness detection and treatment through capacity building of the CHWs. Short training sessions were organized so that they will be able to provide education of caregivers on child eye health, to provide routine vision screening during immunization of children from birth to 2 years, and to refer appropriately.

Informed consent was obtained from the caregiver/mothers. IRB approval was obtained from the University of Ilorin Teaching Hospital, Nigeria (approval number: 00-113-20).

The CHWs were trained during two half-day sessions on child eye health by ophthalmologists, supported by ophthalmic nurses. The training was basic, simple, and focused on being able to appreciate the normal appearance of the eye defined by quiet, clean, equal size, central (in primary position) and steady gaze, round, bright, and equal red reflexes in both eyes. They were not trained to make specific diagnosis, only to appreciate abnormal eyes, and then to refer. The training included the role of vision in overall development of a child and the importance of early detection and intervention in childhood vision problems.

Specifically, the first half-day session was didactic with pictorial representation of facts. Use of screening tools including interview card, Bruckner red reflex test, and instrument vision screener was demonstrated followed by hands-on training. Ophthalmic nurses provided technical support to the CHWs for 3 months until the agreement in their examination was 95%. In addition, large-format, weather-resistant picture charts of various eye problems of childhood were strategically positioned in places leading to and at the well-baby immunization Clinics. This served to reinforce the prerecorded child eye health promotion messages in English and the local languages which were transmitted via speakers mounted in the clinics.

Thereafter, routine early childhood vision screening at the well-baby immunization clinics within primary care centers was performed in the following order by the CHWs before immunization injections were administered to elicit optimal cooperation.

i. Interview of the caregivers – in five thematic areas for all children
ii. Bruckner red reflex test for all children using direct ophthalmoscope light directed to both eyes from 2 m which was found to be more sensitive for the detection of amblyopic risk factors during the pilot phase. It is considered failed if the red reflex from both eyes was not bright enough, not equal, or at the center of the pupil
iii. Instrument vision screener (Welch Allyn SPOT™ Vision Screener [VS100S-B]) for children who were aged 6 months and older.

The vision screening tests were done without the use of mydriatic agents.

The interview questions were recorded on a vision screening ("Yes") card designed along five thematic areas, which are known direct and indirect signs and associations of structural and/or functional visual problems: pregnancy and birth issues, mother/family concerned for eye or functional sight, delay in development, abnormal appearance or function of the eyes, and other general medical conditions. The reliability was checked during the pilot period of 1 month preceding the project. Questions were validated to ensure if they communicated the intended meaning. The presence of the mother/family having concerns for eye or functional sight was to be used to determine if that alone when compared to the outcome from other four thematic areas would be enough during interview of caregivers to determine the need for referral of the children for further eye evaluation.

The total number of responses documented for each child in each thematic area was based on the certainty and clarity of responses provided by the caregiver during the interview. To compare any two of the thematic areas, the questions to be compared must have been answered in both areas.

Referral criteria included answering "Yes" to any interview question, failed red reflex test (if reflexes from both eyes are not round, central, equal, and sufficiently bright), and/or as determined by the instrument vision screener referral criteria (misalignment of the eye of 8 D, 2.25 D/2 D astigmatism, 2 D myopia, 3.5 D/3 D hyperopia, 1.5 D/1 D anisometropia for 6–12 and 12–24 months old, respectively, 1 mm anisocoria).

Later, in the project life, whenever the instrument vision screener failed to screen after several attempts, the child was referred. Referral was directed to the tertiary child eye unit for comprehensive examination and appropriate interventions.

IRB (ethical) approval was obtained from the university ethical review board and informed consent from caregivers. Data collection was conducted daily, and data management was with both Microsoft Excel and SPSS-IBM version 21 software.

Results

Over a 6-month period of instituting vision screening for preschool children during their visits for scheduled immunization, 38 CHWs were trained. A total of 5609 children enrolled by four well-baby immunization clinics, comprising 2779 males and 2830 females, with a male: female ratio of 1:1.1, were screened. Vision screening lasted an average of 5 min per child; it was 3 min for interview, and Bruckner red reflex and instrument vision screener lasted about 2 min.

The five thematic areas for interview are as outlined in the vision screening card. With respect to interview

questions and validating the need or otherwise for questions in the four thematic areas of pregnancy and birth issues, delay in development, abnormal appearance or function of the eyes, and other general medical conditions compared with if other people/caregivers expressed concerns about the eye or visual function in the child are presented in Table 1.

The total number of responses documented for each child in each thematic area was based on the certainty of response provided by the caregiver during the interview. This differs from question to question; hence, the differences in frequencies are shown in Table 1.

Even though mother having concern about the child's eyes was the most common reason for referral (82.7%), it was considered as being inadequate on its own because a significant proportion of mothers did not express concern for vision even in obvious cases. Concern was expressed by only 26.3% in the presence of delayed development, 31.6% in cerebral palsy, 33.3% because of premature birth, 36.4% with nystagmus, and 50% in the presence of strabismus or leukocoria [Table 2].

To compare mother's having concern to the other thematic areas, both questions must have been clearly responded to by the caregiver; hence, the differences in the frequencies between are presented in Tables 1 and 2.

Bruckner red reflex test was found to be able to identify children with refractive errors from 3 D.

Referrals for comprehensive eye examination at the tertiary pediatric ophthalmology unit included 537 (9.6%) from interview, 628 (11.2%) from Bruckner red reflex test, and 163 (12.0%) from instrument vision screener, which was used on a subset of 1358 (24.2%) children aged 6 months and older [Figure 1]. Altogether, 368 (6.6%) children were referred by both interview and Bruckner test. This was 68.5% of the 537 referrals from interview and 58.6% of the 628 referrals from Bruckner test, and the difference in referral pattern was statistically significant. In addition, 23 (14.1%) of the 163 referrals by the instrument vision screener were not referred from Bruckner red reflex test ($P = 0.02$). The instrument vision screener was the preferred screening method by the caregivers.

It is noteworthy that there were 12 cases of eye pathologies which were previously unknown to the mothers, but picked up by Bruckner red reflex test; and they were unresponsive to screening by instrument vision screener even after several attempts. Six of these children who were over 6 months were confirmed at comprehensive examinations to have cataract and retinoblastoma. This necessitated the decision for automatic referral of all

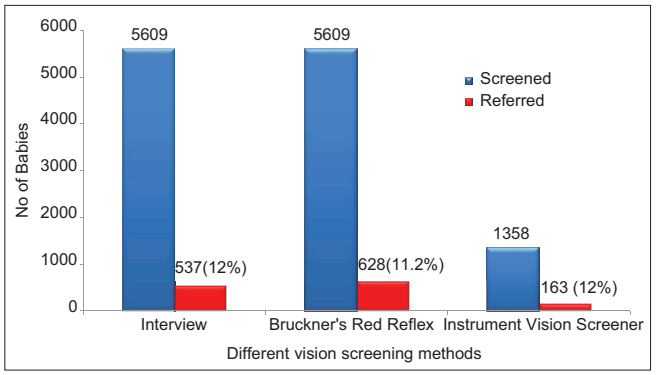

Figure 1: Referrals from different children vision screening techniques. Proportion of children referred from interview, red reflex, and instrument vision screening techniques

Table 1: Children vision screening referral criteria by interview

Referral criteria in 5 thematic areas	Number of caregivers interviewed	Number of children referred	Percentage of children interviewed	Proportion of total interview referrals (*n*=537)
1. Pregnancy and birth issues				
Pregnancy duration ≤32 weeks	5270	66	1.3	12.3
Child did not cry after birth	5468	195	3.6	36.3
2. Mother concerned for eye/sight	5367	444	8.3	82.7
3. Family history/delay in development				
Childhood of visual impairment in family	5407	58	1.1	10.8
Delay in developmental milestones?	5225	21	0.4	3.9
4. Eyes appearance or function abnormal				
Is there a watering eye?	5273	115	2.2	21.4
Child bump abnormally into things	4149	98	2.4	18.2
There is a squint	5429	28	0.5	5.2
Other obvious eye abnormalities-whitish speck, eye dancing, too small or big	5353	21	0.4	3.9
5. Other eye/medical conditions				
Is there cerebral palsy or seizures	5443	26	0.5	4.8
Albinism/other syndrome appearance	5473	11	0.2	2.1
Abnormal head position	5426	6	0.1	1.1

Table 2: Mother's concern compared to other questions as vision screening referral criteria

Referral criteria	Mother have concern about sight function		Total	*P*
	Yes	No		
Pregnancy and birth issues				
Pregnancy duration if ≤8 months				
Yes	21 (33.3)	42 (66.7)	63	0.000
No	358	4664	5022	
Total	379	4706	5085	
Child did not cry after birth				
Yes	106 (56.4)	82 (43.6)	188	0.000
No	304	4781	5085	
Total	410	4863	5273	
Birth weight ≤1.5 kg				
Yes	9 (37.5)	15 (62.5)	24	0.000
No	205	2822	3027	
Total	214	2837	3051	
Is there cerebral palsy, seizure				
Yes	6 (31.6	13 (68.4)	19	0.000
No	429	4848	5277	
Total	435	4861	5296	
Is there a delay in development?				
Yes	5 (26.3)	14 (73.7)	19	0.004
No	406	4631	5037	
Total	411	4645	5056	
Does child bump into things				
Yes	54 (55.7)	43 (44.3)	97	0.000
No	310	3664	3974	
Total	364	3707	4071	
Is there a watering eye?				
Yes	53 (46.5)	61 (53.5)	114	0.000
No	372	4614	4986	
Total	425	4675	5100	
Are there obvious eye abnormalities?				
Yes	13 (61.9)	8 (38.1)	21	0.000
No	411	4742	5153	
Total	424	4750	5174	
Is there is a squint?				
Yes	13 (50.0)	13 (50.0)	26	
No	414	4802	5216	0.000
Total	427	4815	5242	
Abnormal head position				
Yes	3 (50.0)	3 (50.0)	6	0.000
No	421	4812	5233	
Total	424	4815	5239	
Is there whitish speck?				
Yes	5 (50.0)	5 (50.0)	10	0.000
No	414	4822	5236	
Total	419	4827	5246	
Are the eyes dancing?				
Yes	4 (36.4)	7 (63.6)	11	0.000
No	416	4817	5233	
Total	420	4824	5244	

such children whose eyes were unresponsive to the instrument screener.

Among the 628 patients referred, 389 (62%) presented to the tertiary child eye clinic for further evaluation, out of which 262 had nonsurgical (67.4%) treatments. Among the vision-threatening conditions referred were cataract (2.6%), congenital glaucoma (0.8%), retinoblastoma (0.5%), and significant refractive errors (13.4%). Other diseases with short duration, e.g.,

congenital nasolacrimal duct obstruction (30.3%) and ophthalmia neonatorum (12.6%), were also referred from the program.

Cataract was the single most common blinding diagnosis found in 10 among the 5609 (1.8/1000) children 0–2 years examined, and congenital glaucoma in 3 of 5609 (0.5/1000) and retinoblastoma and presumed toxoplasmosis each in 2 (0.35/1000). The prevalence of blindness/severe visual impairment from cataract, congenital glaucoma, and bilateral retinoblastoma identified was 17 among the 5609 (3/1000) children aged 0–2 years [Table 3].

Interview questions provided most – 21 (63.6%) of the 33 cases with normal eye examination (false referrals) findings were related to the question to child did not cry after birth, birth weight, and child bumps into things. Bruckner red reflex test was responsible for 7 (21.2%) while 5 (15.2%) false referrals were from instrument vision screener.

Discussion

The program was piloted at four high-volume well-baby immunization clinics selected from both rural and urban communities. Before the implementation of the vision screening program, vision screening for children was not in existence in spite of the "Childhood Sight Protection Law" in the state.

Use of preexisting personnel and services proved to be an important self-sustaining strategy for child eye health promotion, early detection, and blindness prevention. Caregivers would more likely present children for eye screening during routine immunization despite that utilization of health facilities in the developing world is generally suboptimal.[16] Because preschool age children would usually not complain of visual symptoms, different strategies must therefore be deployed for early detection for early intervention.

Table 3: Diagnoses among referred children from vision screening at well-baby immunization clinics

Diagnosis	Frequency (%)
Bacterial conjunctivitis	51 (13.1)
Ophthalmia neonatorum	49 (12.6)
Congenital nasolacrimal obstruction	118 (30.3)
Strabismus	28 (7.1)
Refractive error	52 (13.4)
Cataract	10 (2.6)
Ptosis	3 (0.8)
Albinism	10 (2.6)
Presumed toxoplasmosis	2 (0.5)
Retinoblastoma	2 (0.5)
Congenital glaucoma	3 (0.8)
Cerebral palsy	26 (6.7)
Others (optic atrophy, myasthenia gravis)	2 (0.5)
Normal	33 (8.5)
Total	389 (100)

The second half-day training program was sufficient to build the capacity of CHWs who had no previous general or child eye health training. Having ophthalmic nurses on hand at the onset of the program provided technical support and served to validate the work of the CHWs. Although, in many regions of the world, screening for children's vision is conducted at or after school entry, our study supports the considerable benefits of preschool vision screening. This is because of the low general and especially female literacy level (total population – 59.6%; male – 69.2%; female – 11%),[17] poor eye health service coverage, and eye health education in our environment.[18]

All the children who presented for immunization within the period of this evaluation had eye screening. None of the mothers/caregivers objected to having their babies' eyes screened. This indicates the appropriateness and acceptability of this model of preschool eye screening program in these communities. The vision screening program made the best possible treatment readily available to the screened children by ensuring that children got timely and immediate referral and appropriate treatment in the dedicated tertiary child eye unit. This is in keeping with the features of a good screening program.[19]

Screening by interview is especially important where an ophthalmoscope or other logistics preclude the use of Bruckner red reflex or the instrument vision screener. Nevertheless, the children vision screening program showed that asking questions on caregivers' concern is essential but not enough during well-baby checks; this is because caregivers are more likely to be concerned when both eyes are involved and severe enough to affect visual functions.

Interview based only on mother's concerns has limitations because some children needing intervention will be missed. This is evident by the fact that a significant number of mothers did not express concern for obvious sight-threatening conditions apparently because they did not appreciate the impact or are just not capable of identifying the problems. Therefore, asking other specific questions should be used to support early detection. In addition, training of middle-level workers of well-baby clinics to pay attention to the appearance of the eye and general build of a child will further improve early detection of childhood vision problems.

However, to detect the presence of uniocular problems, moderate refractive errors, anisometropia, and other

amblyogenic risk factors, some early and posterior cataract and retinoblastoma which may otherwise not be apparent to a mother/caregiver or health workers. The Bruckner red reflex test is invaluable where instrument vision screener is not available or fails to screen.

The instrument screener by design is to be used in children aged 6 months or older and was just used for a subset of the children in the present study. Expectedly, the referral from it was higher compared to 11.2% from Bruckner test and 9.6% from interviews which are more subjective.

As expected, the instrument screener identified more cases of significant refractive errors which might have been missed by the more subjective interview and Bruckner test. The instrument screener is therefore valuable in this regard coupled with the fact that it is time-saving and able to screen a large number. It is also less technical to use and can therefore be used by more people who are not necessarily involved in eye care; family also tend to be more satisfied with instrument screeners because they can read the recommendations on the display screen of the machine.[20]

The use is limited by the high cost which may make it unavailable in many high population communities in developing countries. The minimum screening age of 6 months limits its applicability to earlier childhood problems. It is mostly limited by its inability to screen certain vision- and life-threatening conditions.

It is particularly noteworthy that the failure of the instrument vision screener to screen and refer (even after several attempts) some sight- and life-threatening conditions, which turned out to be cases of cataract, and retinoblastoma is a significant limitation to its use, thereby suggesting that whenever the machine fails to screen an eye, it should lead to automatic referral. This might have been because of more pigmentation in our patients or genuine limitation of the instrument vision screener when used earlier than the 3–5 years of age as in the recommendation of the American Academy of Pediatrics which states that automated vision screeners as an acceptable alternative to traditional vision screening in children 3–5 years of age.[21]

Our data indicate that among the referrals that presented for further evaluation, only a small proportion had no abnormality diagnosed (8.5%), suggesting that the screening program is efficient and that the referral criteria are appropriate. The high yield therefore makes the tool relevant in early diagnosis and referral for early intervention to prevent childhood blindness. A previous study reported a good agreement between vision technicians and community eye health workers in pediatric eye screening;[22] strengthening this level of care will therefore impact child eye health positively.

However, only 62% of the referrals presented for comprehensive eye examination. This may be due to cost of travel, distance, insufficient appreciation of the impact, and wrong perception about eye diseases as previously reported.[23]

It may be necessary to make available and accessible to the caregivers at the well-baby clinic and mobile eye clinics to deliver comprehensive evaluation. This will serve to augment the vision screening such that only surgical and more complex cases are finally referred to the tertiary child eye unit.

Cases of cataract, glaucoma, refractive errors, and retinoblastoma were discovered during this vision screening program. Visual morbidity and in fact mortality as in the case of retinoblastoma may be greatly reduced with this model of preschool screening in similar environment as it removes the typical late presentation.[24]

The prevalence of blindness/severe visual impairment from cataract, congenital glaucoma, and bilateral retinoblastoma identified in 3/1000 children 0–2 years is higher than between 0.09 and 0.22 per 1000 children reported in two other geopolitical zones of the country.[25,26] This is probably because those studied used key informants in all ages of children in the communities for only 2 weeks. Some of the older children would probably have had the treatment for eye problems they probably had some times before their study compared to the younger children included in this study coupled with the added advantage of using trained CHWs for longer period. The relative high prevalence of blinding eye conditions could also be due to the fact that the project of vision screening was promoted on various mass media platforms, including radio and television thereby increasing uptake among parents.

The proportionately higher number of cataract as a cause of childhood blindness is similar to the previous studies.[25,26]

It is noteworthy that the causes were largely avoidable causes of blindness/severely visually impaired and may therefore be similar to the studies from India in which the prevalence of childhood blindness was between 0.6 per 1000 and 1.06 per 1000 and the prevalence of visual impairment varied between 2.05 per 1000 and 13.6 per 1000.[27]

Conclusion

In our resource-challenged settings, middle-level primary care staff successfully used interview, Bruckner

red flex test, and the instrument vision screener as the effective strategies for early detection, referral, and intervention for childhood eye disorders. The strategies served to complement each other. Specifically, use of interview tools to identify pointers and obvious cause of childhood eye problems was effective but will be limited if dependent only on mothers having concerns. Bruckner red reflex test was more effective in the detection of amblyopic risk factors and life-threatening diseases such as retinoblastoma and posterior, visually significant cataract which the instrument vision screener failed to screen. Whenever the instrument vision screener fails to screen after several attempts, the child should be automatically referred. The instrument vision screener may not be considered sufficient in itself when used in similar populations of children without this caveat.

This model of child eye health promotion using multiple complimentary vision screening methods by primary healthcare workers is recommended for other resource-limited regions. Preschool vision screening by primary healthcare workers in resource-limited settings should include Bruckner red reflex test. If instrument vision screener fails to screen, consider vision- or life-threatening pathology and refer.

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Conflicts of interest

The authors declare that there are no conflicts of interests of this paper.

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