Amblyogenic risk factors and validity of vision screening using spot-screener among kindergarten children in Qassim region, Saudi Arabia

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Abstract:

PURPOSE: The purpose of the study was to present the outcomes of vision and amblyogenic risk factor (ARF) screening in kindergarten children in the Qassim region, Saudi Arabia.

METHODS: In this cross-sectional study, an optometrist conducted first-level screening in a kindergarten using a spot screener (Welch Allyn) in 2023. Refractive status and ocular alignment were evaluated. The visual acuity of each eye was measured. Those who failed the first screening or had impaired vision were re-evaluated at the second level of screening by an optometrist and pediatric ophthalmologist. Those who failed the screening in Kindergarten were referred to a pediatric ophthalmology clinic for confirmation and management (third level of screening).

RESULTS: We screened 222 children (mean age: 5.9 ± 0.4 years, 111 boys). A total of 59 (26.6%) children failed the spot vision screening test. A vision screening test by an optometrist identified 58 (26.1%) children with impaired vision. Refractive errors (REs) for children who failed the spot screener included hyperopia in 4 (6.7%) children, high myopia (>6.00 D) in 2 (3.4%) children, and astigmatism in 53 (89.83%) children. Compared to the evaluation by optometrists and pediatric ophthalmologists at KGs, spot screening had 0.845 sensitivity and 0.939 specificity. Validity parameters differed for RE, vision impairment, amblyopia, and strabismus. Seventy-one (31.98%) children were referred for third-level screening, but only 32 (44.4%) children attended, and among them, the prevalence of amblyopia was 25%.

CONCLUSION: The high prevalence of amblyopia and undetected ARFs necessitate establishing annual vision screening among 3- to 5-year-old children in the study area.

Keywords:

Amblyopia, anisometropia, refractive error, spot screener, strabismus, vision screening

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Introduction

Uncorrected refractive error (RE) and amblyopia are the treatable causes of vision loss in children if diagnosed and treated before the age of 7 years, but some consider its utility up to 13 years of age.[1] If not detected and treated early, they not only affect the child's visual potential but also negatively affect the quality of life, causing deficits in school performance and psychological behavior.[2] Therefore, vision screening for children should be performed at an early age. In addition to ocular assessment at birth and immunization visits for children by pediatricians and nursing staff,[3] vision screening is recommended at 3–5 years of age. The National Center for Children's Vision and Eye Health at Prevent Blindness has published an evidence-based approach to vision screening in children aged 3–5 years.[4] A comprehensive overview compared the vision screening program in 46 countries, and a wide range of variability was noted, but in all those countries, vision screening was performed for children at least once, and all of them screened children aged 3–7 years.[5] To facilitate vision screening for children, the American Academy

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of Pediatrics not only allows but also recommends the use of digital devices for vision screening in children from 3 to 5 years as an alternative to traditional methods.[6] In Saudi Arabia, there is no established national screening program for preschool children, and only a few studies have been performed in the past 10 years on vision screening among preschool children. Al-Rowaily screened preschool children when they underwent preschool health screening at primary health centers.[7] They used an autorefractometer and tested distance visual acuity. Selected cases who failed the vision test underwent noncycloplegic retinoscopy refraction, and based on the spherical equivalent (SE), a type of RE was identified. Alsaqr *et al*. investigated vision in preschool children in Riyadh in 2017.[8] They used the Lea Symbols 15-Line 3 m chart and Mohindra near retinoscopy technique for refraction. They expressed refraction by calculating the SE and accordingly found a 12.7% prevalence of REs.

Qassim is a dry, agricultural, and sandy area in the central region of Saudi Arabia. In 2017, the population younger than 5 years accounted for approximately 120,900, whereas 5–9-year-old children accounted for 119,231. Thus, it is estimated that there could be 84,300 3–5-year-old children who are eligible to enter kindergarten every year, with a boy-to-girl ratio of 50.5:49.5.[9] Nearly 2000 doctors and nurses at 155 primary health centers provide health care in the Qassim region.[10] Pre-primary education for children aged 3–5 years in Saudi Arabia is provided free of charge by the Ministry of Education and is gradually expanding and becoming well accepted among parents. There were 3170 kindergartens in the Kingdom in 2016–2017.[11]

Using a spot screener to screen distance vision in preschool children as part of first-level screening has very promising outcomes. In Japan, children as young as 3.5 years of age were screened in the community, and the tool was found to be very useful for screening for RE and vision impairment. However, this method needs to be complimented with an orthoptic assessment.[12] In Saudi Arabia, one study investigated spot screeners for the first-level assessment of preschool students and found them to be useful.[13] However, in that study, the SE value was calculated for grading RE for a child with only cylindrical RE.

To the best of our knowledge, the validity of spot vision screening in comparison with evaluation by optometrists and pediatric ophthalmologists at KGs has not been verified in Saudi Arabia. We evaluated the challenges in eye and vision screening among 4–6-year-old preschool children and the outcomes of spot and Lea Symbols vision screening at four KGs in 2023.

Methods

The Institute Research Board of Qassim University approved this research. The tenets of the Declaration of Helsinki were strictly adhered to during all research steps. A facilitating letter was obtained from the planning and information department of the General Administration of Education in the Qassim region. A list of the kindergartens in the Qassim region was obtained, and then four randomly selected KGs were contacted for administrative approval. Informed written consent from parents and school authorities was obtained. The school authorities contacted all parents of KG children and sent a letter describing the screening program for their wards, and a signed consent form was obtained. The personal identities of all children were delinked from the data before the analysis. All participating children were screened. The children of the parents who refused to grant permission were excluded from this study. If the child was absent on the day of the examination, he was excluded. Even after repeated attempts and seeking teachers' help, the tests were not carried out if the child was not cooperative. Demographic information about the date of birth and sex of the children was collected from school authorities.

A single optometrist performed the first-level screening, which was performed in the nursing station of the school, where the room had good lighting and facilities to make it a dark room if needed. First, a handheld spot screener (Welch Allyn, Skaneateles Falls, NY, USA) was used for each child and repeated twice for confirmation of the readings. The spot screener steps are described in detail in previous publications.[14] The best-corrected visual acuity was assessed by an optometrist using a Lea Symbols (15-line) acuity chart held at a 3 m distance from the child and kept in a lightbox for even background illumination. Each eye was tested separately. If half or more symbols in a line could not be identified correctly, the LogMAR value of the top line on the chart was considered the correct distance visual acuity. If a child wore spectacles, vision was tested with the spectacles. The refractive status of each eye, spherical and cylindrical values, and the axis of astigmatism, as mentioned on the display of the spot screener, were recorded. The SE of each eye's RE was calculated using the formula (spherical value + [cylindrical value/2]). The reasons for failed tests, such as small pupils, strabismus, and significant RE, were also documented for each child. If the spot screening test failed or vision in one eye or both eyes was 20/40 or less, the child was determined to have impaired distance visual acuity. If the uncorrected visual acuity (UCVA) in two eyes differed by two or more lines, the child was suspected to have amblyopia.

The second level of screening was held at the KGs by a team of optometrists and pediatric ophthalmologists. To detect and identify the type of strabismus, we tested extraocular muscle movement in all cardinal gazes. We performed both near and far cover tests (using a LANG cube). The anterior segment was assessed to look for any external pathology of the eyelid, conjunctiva, and cornea. Using a direct ophthalmoscope (Welch Allyn, Germany), the red reflex was evaluated to rule out the presence of cataracts or another media opacity.

The third level of screening was performed by a single pediatric ophthalmologist in the university clinic. Visual acuity was assessed on an ETDRS E-chart. Intraocular pressure was measured with the help of an air puff tonometer (Reichert, Inc., USA). The refractive status was reevaluated with an autorefractometer (TOPCON, JAPAN). Extraocular muscle movement in all six cardinal gaze directions and the alternate cover test were performed for both near (40 cm distance) (using a LANG cube) and far (3 m distance). If strabismus was present, the extent of deviation was measured with an alternate prism/cover test for both the near and far fixation points. If the deviation was more than ten prism diopters, the child was determined to have strabismus. Anisometropia was defined as >1.00-D differences in either sphere or cylinder values between the two eyes of a child. Slit-lamp examination was performed for all children to examine the anterior segment of the eye. For cycloplegic refraction, we instilled 1% cyclopentolate eye drops three times 10 min apart and waited for a minimum time of 1 h before refraction was tested. This was followed by a fundus examination. Spectacles were prescribed for children with significant REs (myopia ≥1.00 dioptric sphere [DS], hyperopia ≥2.00 DS-astigmatism ≥1.50 DS), failed vision screening (vision equal to or less than 20/30 in one or both eyes), the presence of exotropia or esotropia, or the presence of anisometropia with a 1.00-D difference between the two eyes. The severity of amblyopia was classified as mild if the vision of the amblyopic eye was 20/30–20/40, moderate if it was <20//40–20/150, and severe if it was <20/150.[13] Children who were prescribed spectacles were reassessed after 6–8 weeks of wearing spectacles full time. In the presence of amblyopia, a part-time occlusion of the dominant eye was started.

The first-level screening data, optometrists' assessments at the KGs, and findings of pediatric ophthalmologists' assessments were linked to the child's file using a single identification code. The data were then transferred onto a spreadsheet of the Statistical Package for the Social Sciences (SPSS 25) (IBM, NY, USA). Univariate analysis was carried out using the parametric method. The qualitative data are presented as numbers and percentages. The quantitative variables are presented as the means and standard deviations. The findings of pediatric ophthalmologists and optometrists were considered the gold standard. The findings of the first-level screening by the spot screener were validated by comparison with the gold standard. Sensitivity was defined as an eye with impaired vision or truly detected pathology by a failed spot screening test. Specificity was defined as an eye with normal vision, and no pathology detected by the spot screener as a pass test. The positive predictive value (PPV) of the spot screening test was defined as the proportion of children with RE among all reported failed tests by the spot screener. A negative predictive value (NPV) of the spot screener was the proportion of children without RE among all reported passed tests.

Results

We screened 222 children at four kindergartens in the study area. There were 111 boys and 111 girls. Of the examined sample, 64 (28.9%) were 5 years old, and 158 (71.1%) were 6 years old. In four semiurban KGs, the sample proportion was 18%–20% of the total sample, whereas in one urban KG, this proportion was 42.3%. During first-level vision screening by the spot screener, 163 (73.5%) children passed the test, whereas 59 (26.6%) failed the test. One child failed the test because he had small pupils and therefore could not be tested by spot screening, but his eyes were normal when examined by the optometrist. Ten (4.5%) children used spectacles. Of those who used spectacles, three had high myopia, two had mild myopia, one had mild hyperopia, and four had moderate hyperopia. REs in children who failed spot screening included hyperopia in 4 (6.7%) children, high myopia (>6.00 D) in 2 (3.4%) children, and astigmatism in 53 (89.83%) children (mixed astigmatism [43] + hyperopic astigmatism [7] + myopic astigmatism [3]). Based on an assessment by spot screener, the prevalence of failed vision and amblyogenic risk factor (ARF) tests was 26.6% (95% confidence interval [CI]: 20.8; 32.4). Vision screening by optometrists identified 58 (26.1%) children with impaired vision. Nine (12.7%) of them passed the spot screening test. Five children (7.0%) failed vision screening, although they showed no significant REs. Three children (1.4%) passed the distance visual acuity test and spot screening. However, they were considered to have failed tests: two had exotropia, and one child had high hyperopia per the spot screener test but was not reported to have a failed test (false negative). Of the 59 (26.6%) children who were reported to have failed tests on first-level screening by spot screening test, 10 (16.95%) children had normal distance visual acuity in either eye: two children wore spectacles, seven children had mixed astigmatism, and one child had hyperopic astigmatism. Amblyopia (based on vision screening) was the provisional diagnosis in 26 (11.7%; 95% CI: 7.5; 15.9) children.

The prevalence of strabismus among KG children was 11 (4.0%; 95% CI: 2.1; 7.8). Of those, eight (72.7%) children had esotropia, and three (27.3%) had exotropia. Anisometropia based on refractive status reported by the spot screener for children who failed the test was found in 26 (37.7%; 95% CI: 26.2; 49.1) out of 69 children. Based on an assessment by spot screener, the prevalence of failed vision and ARF tests among the children was 26.6% (95% CI: 20.8; 32.4). When comparing refractive status by spot screener to the UCVA measured by optometrists, we found that 20 eyes had a SE equal to zero. Of them, two eyes had 20/63 vision, six eyes had 20/50, 4 eyes had 20/40, 4 eyes had 20/32, and 3 had 20/25 vision. The outcome of first-level vision screening by the spot screener was not significantly different by sex (odds ratio [OR] =0.87, 95% CI: 0.5; 1.6, P = 0.65), age group (OR = 1.6, 95% CI: 0.8; 3.2, P = 0.18), or KG (X^2 = 0.18, Df = 3, P = 0.67).

We compared the spot screener-based presence of ARFs and impaired vision due to significant RE with the presented distance visual acuity on Snellen's chart assessed by the optometrists at the KGs [Table 1]. The results of first-level screening by spot screening and optometrists' assessments of visual impairment and other ARFs differed significantly.

After screening at the KGs, 71 children were referred to the pediatric ophthalmology clinic for the third level of screening.

Only 32 (44.4%) children attended the pediatric ophthalmology clinic visit. The remaining 39 (54.93%) children did not attend because of the following reasons: eight children were not able to attend due to social issues, seven children did not respond to the phone calls or text messages, six children followed up with private hospitals (four already used glasses and had regular follow-ups with an ophthalmologist, and two did not use glasses before our screening but went to a private hospital and were prescribed glasses), and the parents of 18 children were not convinced that their children had REs.

Strabismus was diagnosed in 5 (15.63%) children: 4 children were diagnosed by first-level screening (esotropia), and only one was newly diagnosed by second-level screening (intermittent exotropia).

The prevalence of amblyopia was 25% (8 children affected out of 32). Amblyopia was mild in three (37.5%) children, moderate in four (50%) children, and severe in two (25%) children. Anisometropia was diagnosed in 6 (18.75%) children. Anterior segment evaluation revealed that 16 (50%) children had inferior exposure keratopathy, one (3.13%) child had mild active vernal keratopathy, one (3.13%) child had anterior blepharitis, two (6.25) children had mild allergic conjunctivitis, and one (3.13%) had diffuse dry eye. Posterior segment examination revealed that one (3.13%) had significant disc cupping (0.7 cup: disc ratio) in both eyes but with normal intraocular pressure and normal optical coherence topography findings, and one (3.13%) had 360° peripheral panretinal photocoagulation for retinopathy of prematurity with flat retina. After cycloplegic refraction, 23 (71.88%) children had findings of cycloplegic refraction similar to or within a ± 0.75-D in spot screening. However, nine (28.12%) children out of 32 had different refraction values than those in spot screening: one showed mild hyperopia by spot screener and then developed high hyperopia after cycloplegic refraction, two cases were overminused by spot screening within 1.00 D, five had high cylinder values by spot screening equal to or more than 1.00 D, and one was undermined by spot screening.

The validity of spot screening at the KGs was compared with that of vision screening at the KGs by an optometrist [Table 2]. The sensitivity was 0.845, the specificity was 0.939, the PPV was 0.831, and the NPV was 0.945.

Of the 32 children examined at all screening levels, we studied the validity of the first screening level [Table 3]. The sensitivity of the first level of screening (spot screener + optometrists' assessment) was 0.714, the specificity was 0.4, the PPV was 0.250, and the NPV was 0.833.

We assessed the validity of first-level screening for amblyopia detection compared to that of second-level screening by the pediatric ophthalmology team at the clinic [Table 4]. The sensitivity was 0.375, the specificity was 0.750, the PPV was 33.3, and the NPV was 0.783.

The validity of first-level screening for strabismus compared to second-level screening is given in Table 5. The sensitivity was 0.250, specificity was 0.708, PPV was 0.228, and NPV was 0.739.

Table 1: Visual acuity by optometrist versus spot-screening findings of kindergarten children in Qaseem, Saudi Arabia

Optometrist's assessment	Spot-screening results		Validity
	Pass, *n* (%)	Fail, *n* (%)	
Uncorrected vision (right eye)			
20/20–20/30	158 (96.9)	20 (33.9)	RR=2.86, 95% CI=2.0–4.1, *P*<0.001
<20/30	5 (3.1)	39 (66.1)	
Uncorrected vision (left eye)			
20/20–20/30	156 (95.7)	22 (37.3)	RR=2.6, 95% CI=1.8–3.6, *P*<0.001
<20/30	7 (4.3)	37 (62.7)	
Strabismus			
Present	4 (2.5)	7 (11.9)	RR=0.2, 95% CI=0.06–0.7, *P*=0.01
Absent	159 (97.5)	52 (88.1)	
Amblyopia			
Present	4 (2.5)	22 (37.3)	RR=0.06, 95% CI=0.02–0.2, *P*<0.001
Absent	159 (97.5)	37 (62.7)	
Using spectacles			
No	163 (100.0)	49 (83.1)	RR=1.2, 95% CI=1.1–1.4, *P*<0.001
Yes	0	10 (16.9)	

CI: Confidence interval, RR: Relative risk

Table 2: Validity for impaired vision detection by spot-screener versus vision-screening by the optometrist

	By optometrist at KG		Total
	Defective vision present	Defective vision absent	
Spot screening at kindergarten			
Fail	49	10	59
Pass	9	154	163
Total	58	164	222

Sensitivity: 49/58=84.5%

Specificity: 154/164=93.9%

Positive predictive value: 49/59=83.1%

Negative predictive value: 154/163=94.5%

Table 3: Validity of first level vision screening of Kindergarten children by the optometrist using a spot screener compared with third level screening at the clinic by the pediatric ophthalmology team

	At the pediatric ophthalmology clinic		Total
	Defective vision present	Defective vision absent	
Spot-screening at KG			
Fail	5	15	20
Pass	2	10	12
Total	7	25	32

Sensitivity: 5/7=71.4%

Specificity: 10/25=40.0%

Positive predictive value: 5/20=25%

Negative predictive value: 10/12=83.3%

The team members involved in the first and second levels of vision and eye screening reported the challenges they faced during the vision and eye screening intervention. Only female examiners were allowed at the KGs. The cooperation of parents in bringing their children for second-level screening was poor. The existing ophthalmic and optometry service in the study area had low coverage for eye care for 4- to 6-year-old children in KGs. Parents of some children who were already being treated by ophthalmologists/optometrists declined to attend the second level of eye screening at the ophthalmology clinic. The use of the spot screener was fast and client friendly. The cooperation of the children was excellent.

Discussion

This study generated evidence to promote vision and eye screening of 4–6-year-old children at kindergartens in the Kingdom of Saudi Arabia. The results of the limited sample in this pilot study showed a high prevalence of unattended ARFs. Vision screening by devices combined with vision assessments by an optometrist could be an excellent first-level screening at the primary health-care (PHC) level. The validity parameters of spot screening for amblyopia and ARFs were low.

Table 4: Validity of first-level screening for amblyopia among Kindergarten children by the optometrist using spot screener compared with third level screening at the clinic by pediatric ophthalmology team

	At the pediatric ophthalmology clinic		Total
	Amblyopia present	Amblyopia absent	
Spot screening at kindergarten			
Fail	3	6	9
Pass	5	18	23
Total	8	24	32
Sensitivity: 3/8=37.5%			
Specificity: 18/24=75.0%			
Positive predictive value: 3/9=33.3%			
Negative predictive value: 18/23=78.3%			

Table 5: Validity of first-level screening for strabismus among Kindergarten children by the optometrist using spot-screener compared with the third level screening at the clinic by pediatric ophthalmology team

	At the pediatric ophthalmology clinic		Total
	Strabismus present	Strabismus absent	
Spot screening at kindergarten			
Fail	2	7	9
Pass	6	17	23
Total	8	24	32
Sensitivity: 2/8=25%			
Specificity: 17/24=70.8%			
Positive predictive value: 2/9=22.2%			
Negative predictive value: 17/23=73.9%			

This study can help promote protocols for the prevention of blindness nationwide and implement strategies for early detection and prompt intervention to address issues related to childhood blindness. With the increasing number of graduated optometrists, their placement in PHC could help initiate universal preschool vision and eye screening. The present study used both digital devices and an optometrist in the first level of vision and eye screening, which can be a model that can be replicated in other provinces as well as the Kingdom overall. Third-level screening, although its coverage was less than ideal, suggests that teamwork among pediatric ophthalmologists is vital for managing children identified as having ARFs.

Spot screening was effective, speedy, and acceptable to service providers and young children and a valid screening tool to identify RE, strabismus, anisometropia, and ocular pathologies. The method had high sensitivity and specificity compared to vision testing and assessment for ARFs by an optometrist performed at the KGs. Spot screening of 1023 children aged 6 months to 13 years had a sensitivity of 0.88 and specificity of 0.78. First-level screening detected visual impairment or ARFs in 40% of children.[15] The PPV and NPV of spot screening in our study in identifying impaired vision and other ARFs were 0.831 and 0.945, respectively. This was higher than that noted by researchers in Australia. They screened 2237 preschoolers and found that the PPV and NPV of spot screening were 0.704 and 0.605, respectively.[14] The ability of spot screening to detect amblyogenic factors such as strabismus and anisometropia differed from that of vision screening by optometrists in our study.

Both vision testing by an optometrist and a failed spot screening test revealed the prevalence of RE among more than one-fourth of KG children, which is similar to the prevalence reported in a previous study performed in Riyadh using similar methods among 114 kindergarten children.[13] Thomas *et al*. used Plusoptix A09 for the first-level screening of 94 preschool children and reported that the prevalence of RE was 32%.[16] The prevalence of REs in Western Saudi Arabia was 182 (21%) out of the 865 3- to 6-year-old children.[17] Such a high prevalence of uncorrected RE justifies the urgent need for universal screening in the Kingdom of Saudi Arabia.[18] It also reflects poor coverage of existing eye care services in detecting this asymptomatic, treatable cause of vision impairment in young children. Review of available resources for planning universal screening and training existing human resources in such screening should be a priority of PHC programs for preventing blindness in the Kingdom of Saudi Arabia. Various human resources have been utilized for the first-level screening. They include school health nurses in Oman, ophthalmic assistants, and PHC staff.[19,20]

In the present study, the prevalence of strabismus in 4- to 6-year-old children was 4%. Surprisingly, parents and teachers had not noticed this easily noticeable health issue and had not consulted eye professionals to address it. A study in the USA reported that among 1522 Asian 6-to 72-month-old children, the prevalence of strabismus was 3.55%, and it was 3.24% among 1514 Hispanic children of the same age.[20] A community-based study in Sudan noted low awareness and negative attitudes toward treating horizontal strabismus at a young age.[21] However, when parents of children with strabismus at a tertiary eye hospital at Qassim were interviewed, a high level of awareness and positive attitude for spectacle compliance and treatment of strabismus for their ward was reported.[22] This difference in the level of awareness and attitudes in these two studies could be influenced by selection bias in later studies.

The strategy of assessing refractive status by a digital device complemented with visual acuity testing by trained eye care professionals applied in the present study is helpful. Without a cycloplegia test, which is not practical at KGs, a RE such as high hyperopia is likely to be missed, and a visual acuity test for distance could be normal. However, the child may suffer during near-work activity, especially reading and writing. Repeating the eye and vision assessments of children with failed spot screening tests by the fogging method could enhance the validity of the first-level screening.[23]

The validity of the first-level spot screening in correctly identifying children with RE in our study was high. However, the number of children with the different types of RE was insufficient to compare the validity of the method in children with the different types of RE. The updated guidelines by AAPOS in 2021 cautioned that the validity of spot screening in children with hyperopia is relatively poor compared to that in myopic children.[15]

To test for amblyopia, accurate visual acuity testing is crucial. Screening with digital devices has limitations in detecting amblyopia in a child. Therefore, there could be over-referrals for retesting vision in a clinical setting to identify the difference in visual acuity between the two eyes. With a low response rate for the third level of screening, an accurate estimation of the prevalence of amblyopia could not be made in our study. Systematic reviews and projections have reported that the worldwide pooled prevalence of amblyopia is 1.36% to 1.44% and projected that the global number of people with amblyopia could increase from 99 million in 2019–222 million in 2040. It is therefore recommended to plan a public health strategy to identify amblyopia through screening and manage it.[24,25]

In the first screening level, 20 of the total screened eyes had a SE value of zero. Of those, 60% failed vision screening, and 10% had a vision of 20/60. From this, we recommend not using SE as a predictor of the degree or type of RE.

In the present study, although we had a low level of attendance for the third-level screening, the prevalence of cornea exposure keratopathy was high (50%). In the literature, and to our knowledge, no study has investigated the prevalence of exposure keratopathy among healthy children attending ophthalmology clinics. Published papers mainly discuss the prevalence among critically ill patients admitted to intensive care units or sedated patients, so healthy children have to be studied more.[26,27] Corneal exposure keratopathy in children can affect their daily lives, especially in the morning, because the early hours of the day are the time when patients suffer more.

A few lessons were learned in this pilot study. To identify the status of children with impaired vision or children with ARFs, a pediatric ophthalmologist had to visit the KGs, as parents did not bring their children to the clinic. A study is recommended to understand parents' and teachers' level of awareness and attitudes regarding amblyopia and the need for vision screening. We utilized an optometrist for vision testing as well as a spot screener. This can be easily performed through task shifting. Teachers or PHC nurses can visit the KGs of the catchment area and perform this first-level screening effectively. Due to rules and regulations, we could not utilize male volunteers in the first-level screening to visit KGs and interact with children. The service providers, teachers, and school administrators found spot screening an efficient tool for eye and vision screening, which was well accepted by young children. These advantages and challenges should be noted while expanding the screening beyond the study sites. When planning a study, school holidays and suitable seasons to visit different KGs should be kept in mind to complete the screening in the stipulated time frame.

There were a few limitations in this study. Since KG holidays started in the middle of screening, male examiners were not permitted to screen the children, and a less than desired cooperation of parents resulted in a small sample and low coverage of the third-level screening.

Conclusion

The high rate of uncorrected REs among 4–6-year-old children at KGs justifies the need for urgent universal vision and eye screening. In a country with resources and free accessible health services, 16% coverage of refractive services for children with suspected RE suggests that these children are either asymptomatic or parents and child health-care providers are unable to detect and refer them to eye care professionals. The reluctance of parents to approach pediatric ophthalmologists even after proactive communication by eye care professionals reflects low awareness and negative attitudes of parents toward eye health. Spot screening has high efficiency in detecting REs but relatively low validity for identifying other ARFs. A combination of manual vision testing and device-supported RE assessment is an excellent first-level screening that must be complemented by higher coverage for second-level screening at the clinic where the pediatric ophthalmology team or optometrist could provide further management.

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Conflicts of interest
There are no conflicts of interest.

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