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ABSTRACT

Purpose: Explore door-to-door eye screening in India as a model to reach school age children in need of eye care, especially during school closures due to the Covid-19 pandemic.
Methods: Children between 5 and 18 years were screened in an urban-slum of Delhi from September 2020 to March 2021. Screening included capturing ocular complaints, visual acuity and conducting a torchlight examination. Children with any eye-related complaints, gross abnormality or a LogMAR acuity of more than 0.2 in either eye were referred to the nearby vision centre. Data were disaggregated by gender and age group. Reporting after referral and proportion of true positives referrals were used to assess the model.
Results: 32,857 children were screened. 55% were boys. Only 917 children (2.8%) had previous eye examinations. 1814 (5.5%) children were referred. Overall compliance rate amongst those referred was 59% (1070 of 1814) and compliance was significantly higher (72%) amongst those referred with poor vision as compared to those with only ocular morbidities (38%). Overall compliance was significantly higher amongst older age group (64% vs 50%) and amongst girls than boys (61% vs 56%). 3.9% children were detected with refractive error (RE) and 2.5% with uncorrected RE which was significantly higher in girls and in older age group. Of 1070 children reporting after referral, 85% had confirmed diagnosis for RE or other ocular pathology.
Conclusion: Door-to-door screening had good referral compliance and positive predictive value. We recommend this model as a supplement to school screening especially in regions with low enrolment and high absenteeism in schools.

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Door-to-door screening; school age children; vision screening; north India; Covid-19 pandemic

Background

Majority of the blind and visually impaired paediatric population is resident in the developing world.[1] In India, prevalence of childhood blindness and visual impairment are estimated to be between 0.6 and 1.06 per thousand, and 2.05 and 13.6 per thousand, respectively.[2] Refractive error (RE) in children has been shown to be a major public health problem with prevalence reported as high as 8% in a recent systematic review.[3] Various modalities including the use of photoscreener has been advocated as recommended practice for screening preschool children.[4] School eye screenings programs have been developed as a cost-effective model.[5] A case has also been made for out-of-school screening in areas with low school attendance and enrollment.[6]

Our organization is a non-profit network of eye hospitals, providing services through the pyramidal model of eye care delivery across north India,[7] with school eye screening programs regularly implemented across the catchment areas. However, the precipitous onset of the Covid-19 virus, and the subsequent lockdown due to the pandemic,[8] resulted in school closures across the country, which persisted even after the lockdown. Thus, we shifted to door-to-door screening as a strategy to reach children in need of eye care in the urban-slums of Delhi. This study's purpose is to assess this model for eye care delivery to children in the school-going age group and share results from our program.

Methods

Study design and period

This is a prospective cross-sectional study. Screening was carried out from September 2020 to March 2021 in the urban-slum region of Delhi, within three kilometres of existing vision centres (VCs).

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Inclusion-exclusion criteria

Two of our VCs are in very densely populated urban-slums of Delhi. As extensive school screening programs have been conducted in one of these regions in the past, only the other one was included in this program. Originally, all children were to be included in the program, however, once screening was initiated, examination of pre-school children became difficult as semi-darkness required for red-reflex testing necessitated screeners to enter the households and be physically close to the children – an unsafe practice for both the children and the screeners during the pandemic.[9,10] Thus, parents were encouraged to bring children under the age of five years to the VC to be screened using a spot-screener from a safe distance.[11] As no screening was done in the field for these children, they were excluded, and only those aged five and above, whose parents provided verbal consent, were included in this study.

Pilot, training, data collection and screening

Protocols for data collection and screening were developed and pilot tested on children visiting the VC. The data collection and screening team consisted of eight members who were trained for a period of one month. Training included an introductory module to orient the screeners to the purpose of screening, followed by a module on communication skills, emphasising effective communication and counselling of guardians over multiple sessions, with role play. Further, training was provided to accurately capture complaints and familiarize the team with the need for each question. Clinical modules covered capturing visual acuity (VA) using Peek application and appropriate cut-offs. For vision technicians (VTs), separate sessions were held for torch-light examination on children and common disorders. Teams also underwent clinical postings.

Trainings were conducted by clinical optometrists and included initial supervision in the field. At the end of the training, VTs were individually tested for their torch-light examination and Peek VA skills and the rest of the team members were individually tested for Peek VA skills only. They were permitted to work in the team only when their findings matched with the trainer for atleast 75% of children (out of a total of 20).

Six of the team members were involved in screening – three community health workers (CHWs) were trained to capture demographic data, VA, and any complaints, while the three VTs conducted torchlight examinations. They were divided into three teams- each with one VT and one CHW. Out of the two members who were not involved in screening, one was trained to use photoscreener at the VC to screen children under five years who reported there. The other was further trained as a patient counsellor responsible for encouraging reporting of the children referred from the field and delivering glasses.

Screening teams spent four hours a day in the field conducting door-to-door screenings as per the process depicted in Figure 1. The remaining working hours were spent at the VC and travelling between the VC and the screening area. While at the VC, the VTs conducted examinations including refraction of the children reporting from the field, while the CHW assisted the VT and maintained program related data.

Covid-19 related safety protocols were observed and a minimum of two meters of distance was observed while examining children. Vision was recorded using PEEK acuity application on a smart phone at a distance of three meters.[12,13] Screeners were provided a measuring tape to measure the distance accurately. Care was also taken to record VA outside the homes-avoiding any direct sunlight on the phone screen. A basic torchlight examination was carried out from a distance to rule out any gross abnormality or any misalignment of the eyes. Any adult in the household complaining of ocular issues was offered free referral to the VC without examination.

Children with any eye related complaints, gross abnormality on examination or a LogMAR VA of more than 0.2 in either eye (<6/9.5 Snellen VA), were referred to the nearby VC. All parents not reporting within a week were contacted via phone. The coordinator made a home visit for those who did not report despite two such calls.

At the VC, children were accompanied by a guardian and underwent detailed examination and refraction. Those needing an ophthalmologist's opinion were called again on the day a paediatric ophthalmologist was to visit the VC. Written consent was obtained where refraction under cycloplegia was required. This was carried out by the VT in the presence of the visiting ophthalmologist. Readymade glasses were dispensed at the VC for children for whom the correct size of frame and lens power were available. For others, these were delivered to their homes within two weeks of refraction.

Data management and extraction

Demographic information was collected along with patient history (any previous eye check-up, previous usage of glasses and existing eye complaints). This data, along with the recorded vision were entered on a web-based platform via smart phones. Data were downloaded in Excel files. Data of children reporting at

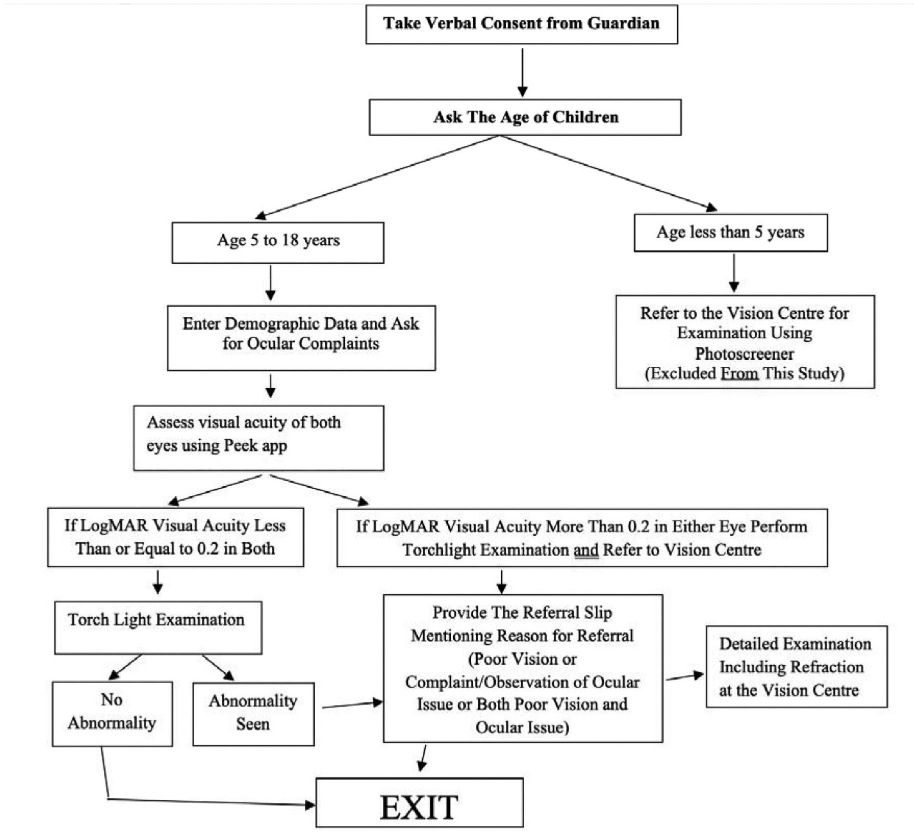

Figure 1. Flow of door to door screening for children [Original].

VC were extracted from VC management system and surgical data from hospital's electronic medical records.

Analysis

VA of more than 0.2 LogMAR was considered as poor vision for the purpose of analysis. Frequency and distribution of poor vision, eye complaints, previous eye check-up, and RE was analyzed as percentages. Children were categorized into two age-group categories of five to ten (equivalent to primary school age group in India), and 11-to-18-year-olds. Any child with poor vision, detected with a spherical equivalent of 0.5 dioptres or more on refraction, was considered to have RE. Any child needing a new pair of glasses or replacement of glasses to reach a VA of 0.2 LogMAR or less was considered to have uncorrected RE.

The door-to-door screening model was assessed using parameters of screening per day, screening per day per screener, reporting amongst the children referred and positive predictive value (PPV, proportion of true positives among referred children) of the referrals made by screeners. Data were disaggregated by gender and age group. The significance of the difference was checked using chi-square test. Statistical analysis was done in R version 4.0.5 and a p-value of less than 0.05 was considered significant.

Ethical considerations

This study was approved by the Ethics Committee of the organization (IRB/2021/May/02) and follows the tenets set in the Declaration of Helsinki.

Results

A total of 32,857 children in 11921 households were screened in the study period of 159 days. 55% were boys and 55% were over 10 years of age (Table 1). The geographical area that was covered by all teams together was within Bhalswa Jahangirpur in Delhi, where the estimated population of children in 6–18 age group

Table 1. Age and sex distribution of children screened door-to-door [Original].

Age group	Boys	Girls	Total (%)
5–10 years	7923	6916	14839 (45.2%)
11–18 years	10201	7817	18018 (54.8%)
Total (%)	**18124 (55.2%)**	**14733 (44.8%)**	**32,857**
Mean (age) ±SD	11 ± 3.23	11 ± 3.26	**11 ± 3.24**

was 56,778.[14–16] 578% of those were covered in the study period. 1814 children (5.5% of those screened) were referred to the VC.

Previous eye examination history of children

917 (2.8%) children had got their eyes examined previously. This was significantly higher amongst girls than in boys (3.2% vs 2.5%: p-value<0.001), and amongst the older age group (3.8%) than in the younger age group (1.6%, p-value<0.001). Advice given at the previous eye check-up was available for 895 children (Table 2).

Referral and reporting at the VC

Screening teams referred 1814 children (5.5% of total children screened) to the VC, and referrals had a clear increasing trend with age. Of the 1122 children referred with poor vision with or without ocular morbidity, 810 (72%) reported at the VC for further follow-up (Table 3). Reporting compliance amongst children detected with poor vision did not significantly differ across age or gender. However, it was significantly higher than the reporting compliance amongst children with ocular morbidity alone (260 out of 692; 38%, p-value<0.001). Overall compliance rate amongst those referred was 59% (1070 of 1814 referred). Overall compliance was more amongst the older children than the younger ones (64% vs 50%, p-value<0.001) and amongst girls than boys (61% vs 56%), however, the latter was only suggestive of a significant difference (p-value = 0.050).

Children with poor vision

Of 32,857 children screened, data on the VA of one or both eyes were missing for 88 children. However, three of them had poor vision in the eye for which information was available, the remaining 85 children were excluded from this analysis. 1122 (3.4%) had poor vision in one or both eyes. Poor vision was found to be significantly more in girls and in older age groups (Table 4).

Table 2. Advice received at the previous eye check-up across age groups [original].

Advice Received	5–10 Years (%)	11–18 Years (%)	Total (%)	p-value
Spectacles	156 (70%)	574 (85.4%)	730 (81.6%)	0.000
Medicine	62 (27.8%)	96 (14.3%)	158 (17.7%)	0.000
Operation	5 (2.2%)	2 (0.3%)	7 (0.8%)	0.012
Total	223 (100%)	672 (100%)	895 (100%)	
Uptake of Glasses Amongst Those Adviced	97 (62.2%)	418 (72.8%)	515 (70.5%)	0.01289
Percentage of All Children Wearing Glasses Amongst Those Screened	0.65%	2.32%	1.57%	<0.001

Table 3. Referrals and compliance to referral.

	5–10 Years			11–18 Years			Total		
	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls	Total
Referred to the VC After Screening									
Children with poor vision without any ocular morbidity	148	151	299	298	372	670	446	523	969
Children with both (poor vision and ocular morbidity)	22	35	57	31	65	96	53	100	153
Children with poor vision with or without any ocular morbidity	170	186	356	329	437	766	499	623	1,122
Children with ocular morbidity without poor vision	153	152	305	182	205	387	335	357	692
Total children referred	323	338	661	511	642	1,153	834	980	1,814
Reported at VC									
Children with poor vision with or without ocular morbidity	118	129	247	233	330	563	351	459	810
	69.4%	69.4%	69.4%	70.8%	75.5%	73.5%	70.3%	73.7%	72.2%
Children with only ocular morbidity without poor vision	42	43	85	78	97	175	120	140	260
	27.5%	28.3%	27.9%	42.9%	47.3%	45.2%	35.8%	39.2%	37.6%
Total children reported	160	172	332	311	427	738	471	599	1,070
	49.5%	50.9%	50.2%	60.9%	66.5%	64.0%	56.5%	61.1%	59.0%

Table 4. Percentage of children with poor vision by age and sex [Original].

Poor Vision (LogMar > 0.2)	Boys	Girls	Total	p-value (Boys vs Girls)
Younger Age group (5–10 Years)	170 (2.2%)	186 (2.7%)	356 (2.4%)	0.036
Total	**7885**	**6886**	**14771**	
Older Age group (11–18 Years)	329 (3.2%)	437 (5.6%)	766 (4.3%)	<0.001
Total	**10188**	**7813**	**18001**	
Combined				
Low (LogMar > 0.2)	499 (2.8%)	623 (4.2%)	1122 (3.4%)	<0.001
Total	18073	14699	32772	
p-value (younger vs older)	<0.001	<0.001	<0.001	

Children with ocular morbidity

845 children were referred with one or more eye complaints. The three most common conditions found were continuous rubbing of eyes (0.98%), followed by discharge (0.79%), and squint (0.29%). The preponderance of ocular morbidity was higher amongst girls than boys ($p < .001$) and in the older age group than the younger one (p-value<0.001).

Refractive error and uncorrected refractive error

A total of 1292 children were detected with RE out of 32,857 screened (3.9%), 777 were newly diagnosed with RE, while 515 were found to be wearing glasses at screening. Fifty-four children already found wearing glasses at the time of screening were prescribed new glasses to improve their vision to 0.2 LogMAR or less. Thus, number of children with uncorrected RE (unmet need) was estimated to be 831, that is, 2.5% (777 newly detected and 54 with inaccurate glasses). They were provided new glasses. Table 5 shows the age and gender split of the rate of RE and its unmet need. The preponderance of RE was significantly higher in the older age group and amongst the girls. The magnitude of unmet need followed the same pattern across age and gender.

Ocular morbidity

At the VC, the paediatric ophthalmologist made 10 visits during the study period and examined 208 children (98 younger and 110 older, average 21 children/visit). The main reasons for ophthalmologist's consultation amongst the children recalled were- strabismus in 39.8% of younger and 45.9% of older children; detailed retinal examination in 36.7% of younger and 33.9% of older children; and cataract in 5.1% younger and 5.5% older children.

Per day screening

The average number of children screened per day during this period were 207, by all teams combined. The three teams screened 11243, 10735 and 10879 children each. The average number of children screened by a team were 69 per day and by a screener were 34 per day. The average time per child was around 3.5 minutes. As one team member captured the demographic data and complaints, the other completed the torchlight examination.

PPV

810 children reported at the VC after being referred for poor vision. Of these 695 were found to have poor vision at the VC (PPV of 86%). Of the total 1070 children who reported at the VC following referral by the door-to-door teams, 912 had confirmed diagnosis for RE or some other ocular pathology. Thus, the overall PPV of the door-to-door screening process was estimated to be 85%.

Discussion

As the pandemic continues, schools have remained closed for over a year, because of which school eye screening programs could not be conducted. After the period of initial national lockdown in 2020, we decided to conduct door-to-door vision screening in urban-slums of Delhi, to provide eye care services to children. An obvious strength of this model is the possibility of screening pre-school children and detect those with amblyogenic factors. Exclusion of children under the age of five years due to the pandemic was a major limitation of our study. In future, when social distancing is not mandated, screening for pre-school children using innovative equipment like Arclight,[17,18] can be included to take full advantage of this model.

We successfully screened a large number of children (32,857). To the best of our knowledge, ours is the first study reporting results from such a door-to-door program for children since the start of the pandemic, while previous reports are from school-screening programs or field-based studies conducted before the pandemic.[19–24] Our results highlight the need for such services as less than 3% of children had had an earlier eye check-up.

Table 5. Refractive error and uncorrected refractive error in boys and girls in different age groups [original].

	5–10 Years			11–18 Years			Total		
	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls	Total
RE	154 (1.9%)	161 (2.3%)	315 (2.1%)	417 (4.1%)	560 (7.2%)	977 (5.4%)	571 (3.2%)	721 (4.9%)	1,292 (3.9%)
		p-value = 0.11			p-value<0.001			p-value<0.001	
	p-value for testing the proportions of RE between two age groups (< 0.001)								
Uncorrected RE (Unmet need)	102 (1.3%)	123 (1.8%)	225 (1.5%)	244 (2.4%)	362 (4.6%)	606 (3.4%)	346 (1.9%)	485 (3.3%)	831 (2.5%)
		p-Value = 0.018			p-value<0.001			p-value<0.001	
	p-Value for testing the proportions of RE between two age groups < 0.001)								

More than 5% of the children screened required a referral to undergo a detailed examination either due to ocular morbidity or poor vision. This is comparable with other studies from India which found the prevalence of presenting VA of 20/40 or worse in the better eye between 2.6% and 6.4%.[19–23,25] Overall, we found around 4% children with RE and 2.5% with uncorrected RE. A previous study from Delhi,[19] had found uncorrected RE to be 6.4% while another from rural India,[20] found this to be 2.7%. Similar studies from Nepal, China and Chile had found presenting VA of 0.5 (20/40) or worse in at least one eye to be 2.8%, 10.9% and 14.7%,[24,26,27] respectively.

We found less girls in our survey but this correlates with the low sex ratio of Delhi as per the last census.[28] Significantly more girls, and more children above 10 years of age, were found to have poor vision at screening and uncorrected RE upon examination. The unmet need in girls was higher in our study in contrast to other studies where gender was not significantly associated with uncorrected RE.[19–22,24,26,27] This could be due to less attention being paid to the complaints of a girl child leading to fewer check-ups as reported in some earlier studies from India and similar developing nations for cataract surgeries.[29] In concordance with other studies, we also found RE to be significantly higher in the older age group than the younger one (5.9% vs 2.4%).[19–22,24,26,27] Also, similar to the RE study in children conducted in China,[26] we found higher RE in girls. This could be due to less outdoor activities by girls in general in that age group in these communities as compared to boys, leading to higher myopia, which is the commonest RE in school going age group.

Reporting of children at VCs after referral for poor vision was found to be more than 70% despite the ongoing pandemic. This was much more than results reported in even developed countries, where only 25% children reported after referral from school eye screening, with parental consent.[30] Previous literature from a school eye program in a developing country has shown parental mistrust as a factor affecting reporting after referral.[31] Engagement of parents or guardians has been shown to be vital in any program for children,[32–34] and the door-to-door model enabled us to connect directly with the guardians. Moreover, presence of a dedicated counsellor helped with high reporting. In our study, compliance to follow-up was found to be similar for boys and girls and effective parental counselling could have been the key. The reporting compliance amongst children referred for only ocular morbidity was found to be lower (38%) thus bringing the overall compliance down to 59%. A possible reason for this could be that some of the main issues reported were itching and discharge from eyes. Further, during the pandemic, parents expected medication to be provided at the doorstep rather than by visiting the VC for what they considered as minor ailments. However, reason for noncompliance was not queried from all households and that is a limitation of our study.

We found a very high PPV of around 85% amongst children who reported to the VC after being referred for poor vision, with or without ocular morbidity. This is much higher than that reported through school screening by teachers,[20,34,35] and thus validates the training provided to the screeners. Also, presence of VTs, who are trained for vision testing and refraction, strengthened the teams. This high PPV is especially useful during the pandemic as it prevents any unnecessary risk to the families from travel and reduces undesirable overcrowding at the health centres. Post- pandemic, we intend to train community workers in conducting torchlight examinations in an effort to bring down the cost of the program.

The teams could effectively screen more than 200 children per day with an average of 69 children per team per day and unlike school screenings absenteeism or low enrolment wasn't an issue.[6,36–38] The average time per child screened was less than 4 minutes. This was made possible by the two-member team composition with well-defined functions, presence of multiple kids in the same household and high density of population with very little time spent on travelling between households. We believe that no previous study has reported such high numbers for children screened using door-to-door screening model.

This model worked very effectively as schools were closed, and children were at home. Even before the pandemic, enrolment had already dropped in 2020, with 5.5% not yet enrolled in schools as compared to 4% in 2018 (ASER 2020).[38,39] A similar percentage of children in the school going age group were found to not be enrolled in the urban-slums of Delhi.[40] Absenteeism of around 40% was reported in a study conducted in the urban-slums of Calcutta,[36] and more than 30% was reported in a rural block of north India.[6] Thus, an inherent strength of this model is the possibility of reaching children who would have otherwise been missed during school screening due to dropouts and absenteeism. Some of the children involved in agricultural or non-agricultural work can also be approached in the evenings. Thus, irrespective of the pandemic, this model provides an efficient and effective model, over and above school screening, to improve coverage in areas where enrolment and absenteeism are low.

One of the limitations of our study is that the population from which children were screened was chosen conveniently from urban-slums within three kilometres of our VC. This was done to reduce the need for travel amongst our staff and reduce distance as a barrier to reporting.[41,42] Thus, our results may not reflect the actual prevalence of ocular morbidity in children in all urban-slums of Delhi. The prevalence may be even higher in slums farther away from any health centre. Moreover, the high reporting could also have been due to the VC being located at an approachable distance. Another limitation is the use of non-cycloplegic vision screening which may have caused underestimation of the actual burden of paediatric RE in our study.[43,44]

We found only 3% of children to have a history of prior examination, but these could be underestimations due to the inherent nature of self-reported data. Although, most guardians accepted the screening being provided, we did not collect data of households which refused screening- a limitation of our study. We have recently started collecting this data in a similar urban-slum based children screening program and the refusal rate is less than one percent. We also found a high proportion of children (550 out of 730, 70%) using glasses among those adviced in earlier check-ups. This is much higher than those reported in a recent multicentric study from different regions in India and in a meta-analysis of studies from similar settings.[45,46] This could be due to under-reporting of previous advice by the parents.

Conclusion

We recommend this model during the ongoing pandemic, and even otherwise, to improve coverage in certain areas with low enrolment and high absenteeism. A robust software to collate results of school screening and door-to-door screening within a region can be developed to monitor coverage. Studies investigating reasons for noncompliance and cost-effectiveness would be useful for wider acceptance of this model in different settings.

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