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Original Research

Prevalence of childhood ocular morbidity in a peri-urban setting in Bangladesh: a community-based study

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ABSTRACT

Objectives: To test a model of integrated pediatric eye care delivery and examine the prevalence and factors associated with childhood ocular morbidity in a peri-urban setting in Bangladesh.
Study design: Cross-sectional, population-based study.
Methods: The study was conducted in three phases among children aged ≤15 years. Trained community health workers (CHWs) conducted awareness intervention and identified children with ocular problems. These children were then referred to the base hospital for examination and treatment by ophthalmologists. A pediatric ophthalmologist further examined the children with complicated eye diseases and ensured treatment at a tertiary public eye hospital. Awareness, referral patterns, and health-seeking behavior were also examined. All data were analyzed statistically using Statistical Package for Social Sciences.
Results: CHWs screened 33,549 eligible children and identified 1887 cases with ocular morbidity. The prevalence of ocular morbidity and childhood blindness were 5.63% (95% confidence interval [CI] = 5.27–6.16) and 0.060% (95% CI = 0.03–0.11), respectively. The most commonly observed ocular morbidities were refractive error (3.24%; 95% CI = 3.11–3.45), allergic eye conditions (1.2%; 95% = CI 0.74–1.27), and nasolacrimal duct obstruction (0.52%; 95% CI = 0.25–0.74). Blindness was more frequently seen in children aged <5 years than in those aged 5–15 years ($\chi^2 = 7.25$; $P = 0.007$). The causes of blindness were corneal opacity, congenital eye anomaly, cataract, retinopathy of prematurity, and retinoblastoma. The prevalence of ocular morbidity was higher among older children, boys, children with low parental education and income, and children from households dwelling in slums.
Conclusions: This study demonstrated that in a setting where screening and treatment for vision problems remain low, ocular morbidity among children could be easily identified through well-designed community-based screening programs involving appropriately trained CHWs. Community mobilization, awareness, and early detection of childhood eye

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diseases, with effective referral mechanisms for accessing appropriate care, are crucially important to improve service delivery.

Introduction

Eye health is a fundamental part of early childhood development and of overall health and well-being.[1,2] If untreated, some of the ocular problems that occur during childhood can lead to visual impairment or blindness.[3] The majority of such blindness is either potentially curable or preventable.[4] Visual impairments or blindness may affect an individual's health, employment potentials, educational attainment, and social functioning across the lifespan.[5] Furthermore, visual impairment not only affects the individuals and their families, but also the community and country at large, resulting in a greater loss of productivity.[6]

Globally, an estimated 1.4 million children suffer from avoidable blindness and three-quarters of these children live in the poorest regions of Asia and Africa. Considering the magnitude of the problem, the World Health Organization's (WHO) global initiative for the elimination of avoidable blindness has prioritized the control of blindness in children.[7,8] The prevalence of blindness in children varies according to country-specific socio-economic development and under 5 mortality rates and ranges from 0.3/1000 children in affluent countries to 1.5/1000 children in resource-poor countries.[9–12] A few studies in Asian settings reported varying prevalence of childhood blindness between 0.06% and 0.17%.[11–14]

Bangladesh is a country where 31% of its total population are children below 15 years of age.[15] Over the last two decades, Bangladesh has made remarkable progress in health and human development, as described in *The Lancet* Bangladesh Series and elsewhere.[16–18] Rapid progress in the most important health indicators, such as infant and child mortality, maternal mortality, fertility, and contraceptive prevalence, are remarkable.[19,20] The actual prevalence of childhood ocular morbidity and blindness in Bangladesh is unknown. One school-based study in Bangladesh has reported ocular morbidity at 16.9% in children (aged 5–16 years).[21] A recent estimate suggests that there are approximately 36,000–40,000 children who are blind in Bangladesh, two-thirds being of school age.[22] Thus, up-to-date data on the prevalence of childhood ocular morbidity are crucially needed.

The renewed emphasis in health and development work in Bangladesh is now to ensure well-being and quality of life. Thus, the Strategy for National Eye Care 2014–2020 for achieving Vision 2020 in Bangladesh has included the prevention of childhood blindness as the national priority agenda.[23] Furthermore, the United Nations Sustainable Development Goals include not only ‘reducing child mortality’ but also ‘achieving universal and equitable access to health care for all’.

In 2016, the Government of Bangladesh piloted an intervention package for preventing avoidable childhood blindness in selected subdistricts in Bangladesh by training community workers to visit homes of children for early detection of preventable eye problems and to support and inform parents.[23,24] An understanding of the prevalence of eye problems in young children can potentially inform effective development of programs for avoidable childhood blindness prevention. The current study was conducted in a peri-urban setting of Dhaka, Bangladesh, between 2016 and 2017, as part of a community-based intervention research to test a model of integrated eye care delivery and examine the prevalence and factors associated with ocular morbidity in children aged ≤15 years.

Methods

Study design and location

The study was conducted in three phases using a population-based, cross-sectional survey among children aged ≤15 years in the peri-urban subdistrict of Keraniganj in Dhaka between March 2016 and September 2017. The study area is approximately 10 km from Dhaka city center, with an estimated population of 830,174 people.[15]

Sample size and method

For the sample size calculation, the formula ($n \approx Z_2$ (ρ) ($1 - \rho$)/ B_2) for estimating a population proportion with specified relative precision was used, where ρ is the prevalence of ocular morbidity (7%) and B is the tolerable error. Z was calculated according to the 95% confidence interval (CI). The permissible error was 1.5%, and the detection rate was about 90%. This provided a sample size of 1249 individuals for each cluster or 29,975 for the 24 clusters included in the study.

In the first phase, a two-stage cluster sampling strategy was used to select the study population across all 12 unions of the Keraniganj subdistrict. The primary cluster, defined as a village, was randomly selected using the probability proportional to the size and from a sampling frame consisting of all villages, as outlined in the 2011 Bangladesh national census.[25] Two villages were randomly selected from each union based on the list of 422 villages, which yielded 24 villages, with a total population of 114,976. Within the 24 selected villages, 22,983 households (defined as a group of individuals who were the residents of the study locations and eat from the same pot) containing individuals aged ≤15 years (n = 34,333) were selected for awareness intervention and identification of children with ocular problems. Fig. 1 highlights the overall research process.

Trained community health workers (CHWs) moved from house-to-house questioning the parents of children on ocular morbidity and health-seeking behavior. Repeat visits were made on the same/next day or within 1 week to the households where members were not present. If an adult member

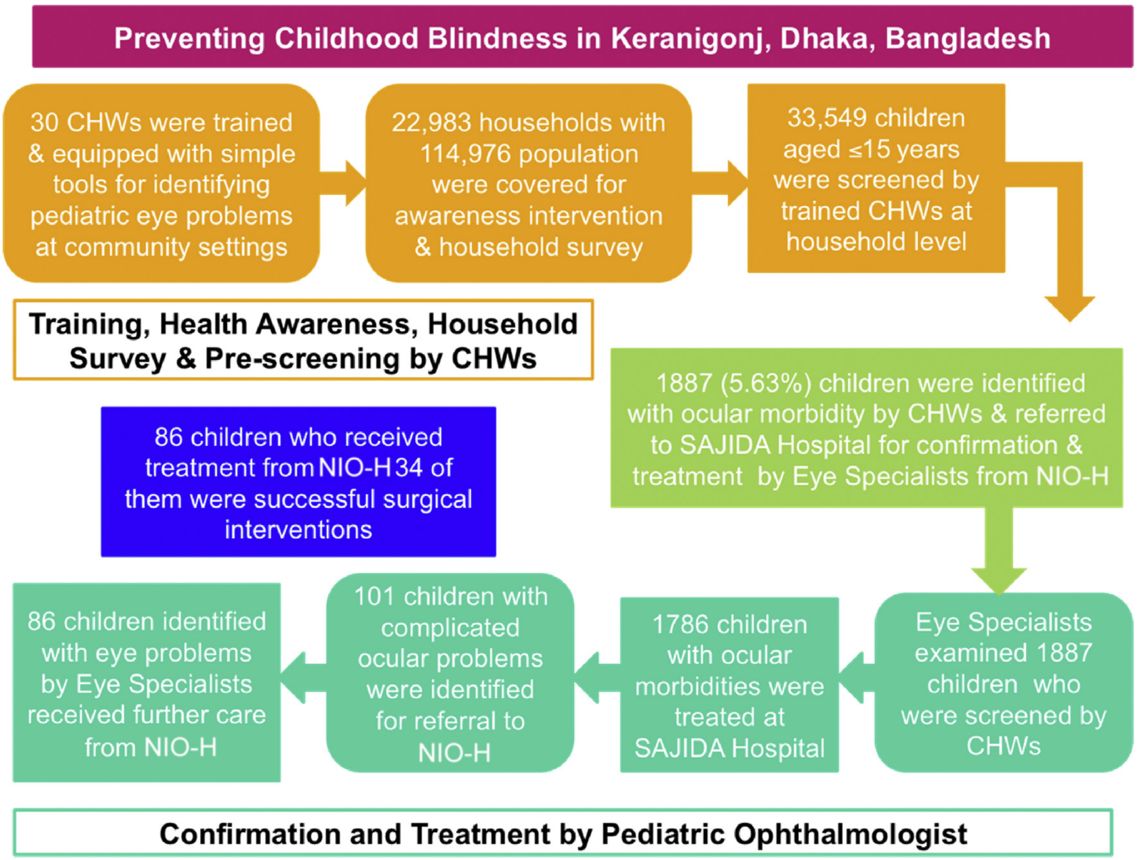

Fig. 1 – The childhood blindness intervention process. CHW, community health worker; NIO-H, National Institute of Ophthalmology and Hospital.

(mother or father) of an eligible household was still missing at the third visit, the household was considered as absent or non-responders. The eligibility of residents was defined as individuals living together in the household for at least 6 of the previous 12 months and taking food from the same kitchen. Non-residents were excluded from the study. Those who refused to take part, were absent, or were unable to understand the consent process were also excluded.

Data collection

Data were collected by 30 CHWs who were part of five research teams, each consisting of six CHWs, a medical officer/research manager, and a program officer/research assistant. The principal investigators accompanied different teams throughout the survey period to ensure compliance with the research protocol and data consistency. CHWs and research team members received 2 days of comprehensive training prior to the survey. CHWs were specifically trained to perform door-to-door basic ocular examinations and vision screening with a focus on the identification of any ocular problems among children and the CHWs communication and counseling skills. The training was conducted by two experienced pediatric ophthalmologists who had previous experience in training staff for similar surveys.

Study aids and field data collection tool

The Directorate General of Health Services and WHO developed study aids (flash cards) for the field workers to use in this study for awareness intervention and morbidity identification (Appendix 1).[26] The pictorial study aids included the procedure for performing basic eye examinations and identifying ocular problems among children.

Defining ocular morbidity and clinical examination

Three questionnaires were used to collect data: (1) a simple household-screening questionnaire (Appendix 2); (2) a comprehensive eye examination form; and (3) a health-seeking behavior questionnaire. The household-screening questionnaire for this study was developed and built upon the findings of qualitative research. The questionnaire covered socio-demographic variables (e.g. age, sex, previous and current residence status, occupation of the parents, household income, and schooling of children and parents), questions related to childhood ocular morbidities (e.g. if children in each household had any ocular problems, illness as deduced from the lay reporting of symptoms by parents), and was followed by a basic eye examination by CHWs for identification of ocular problems. The reported symptoms/complaints were then classified into categories or types of ocular problems. The questionnaires employed a mixture of precoded and open questions (e.g. age, education, and income). The draft questionnaires were piloted among 58 households, which resulted in a number of modifications in the final version.

Written informed consent was obtained from the parent or guardian. CHWs recorded each child's details and performed two tests. First, visual acuity (VA) was measured using Snellen or the illiterate E chart at 6 m distance in outdoor illumination or Lea symbols at a distance of 3 m monocularly (the eye not being tested was covered). If the child wore spectacles, VA was measured with current prescription. Children aged <3 years and those who could not understand the E chart were assessed for their ability to fix and follow a light or an object. Children with VA ≤6/12 in either eye were considered for further evaluation. Second, a basic ocular examination was performed within the house using a pen torch. The focus at this stage was to identify the presence of any abnormality and not to make a specific diagnosis. All children identified with any ocular problems were referred to the base hospital to establish whether any further evaluation, investigation, or treatment was necessary.

At the base hospital, written consent from the accompanying parent was obtained again, and sociodemographic data and medical histories were recorded for all children. The ophthalmologists then performed a detailed ophthalmic evaluation and provided free treatment for minor eye diseases. The examination included the measurement of VA, assessment of the possible causes of ocular disorders, and/or blindness in each eye leading to visual loss and the presence of any other disability. The anterior segment examination was performed using slit lamp biomicroscopy. Children with a presenting acuity of ≤6/12 in one or both eyes were tested with a pinhole and also underwent dilated fundoscopy by the ophthalmologists to determine the cause(s) of visual loss. The pupils were dilated with 1% atropine sulphate ointment. For children aged <1 year, a combination of 0.5% cyclopentolate and 2.5% phenylephrine was used. A full cycloplegia was indicated by non-responsive pupils. The refraction was then performed using streak retinoscopy. A posterior segment examination was performed using the direct and indirect ophthalmoscopes. Blindness was defined as a VA of <3/60 in the better eye, while visual impairment was VA of <6/18 in the better eye.[27] Clinical data were recorded by the ophthalmologists using a form specifically designed for the study, which was a shortened version of the WHO Eye Examination Record for classifying the causes of blindness and low vision in children.[27–29] A senior pediatric ophthalmologist either at the base hospital or the National Institute of Ophthalmology and Hospital (NIO-H) further examined the children with complicated eye diseases and ensured free treatment, including surgical interventions if needed.

Awareness, treatment, referral, and health-seeking behaviors

Data on awareness and health-seeking behaviors were also collected at baseline (from March 2016 to June 2016) and post-intervention (from July 2017 to September 2017) from the parents of those who were identified with ocular problems. The research assistants interviewed the parents using the health-seeking behavior questionnaire. The questionnaire solicited questions on sociodemographic information, childhood ocular problems, and related health-seeking behavior (e.g. symptoms, duration, impact on education, and whether care was sought and if not, the cause of delay). The information relating to the treatment and referral outcomes of children identified with ocular problems was also collected as part of this study. Furthermore, data on yearly caseload at the base hospital (excluding the 1887 cases covered in this study), the referral patterns, and self-referral (excludes 101 referral cases of this study) were extracted from the non-governmental organization (NGO) hospital's database and triangulated with the results of this study. The detailed results of the awareness and health-seeking behavior survey will be reported separately.

Data analyses

All data were analyzed using the Statistical Package for Social Sciences, version 22 (SPSS Inc., Chicago, IL). The data were cleaned for entry errors, and any missing values were entered before conducting the analysis. Descriptive statistics were used to report the data. Age-adjusted prevalence of ocular morbidity, visual impairment, and blindness with 95% CIs were calculated for the whole sample. A P-value of <0.05 was considered significant.

Results

Study participants and response rate

In total, 22,983 households were included in the study, with 34,333 eligible children aged ≤15 years. Of them, 33,549 children were enrolled and screened by the CHWs for any signs of ocular morbidity, giving a response rate of 98%. There were 784 children (2%) excluded, either as a result of absence, non-responsiveness, or parents' unwillingness to participate. The sample comprised 50.5% (16,942) boys and 49.5% (16,607) girls. The mean age of the sample was 9.8 years (standard deviation [SD] = 4.3; range: 0–14 years). Of those children aged >5 years, the majority (93.5%) were attending primary or secondary school, and only 6.5% had no education or were not enrolled in a school at the time of the study. About one-quarter of fathers (23%) and one-third of mothers (30.5%) had no formal education. The majority of the parents (43%) were involved in manual labor.

CHWs screened all children who were enrolled (n = 33,549) and identified 1887 children (5.63%) with possible eye problems, who were then counseled and referred to the base hospital. The mean age of the children identified with ocular problems was 8.4 years (SD = 4.5; range: 0–13 years). Of these children, 52.5% (991) were boys, and 47.5% (896) were girls. Age, sex, household income, and other sociodemographic distributions of the children and their parents are shown in Table 1.

Prevalence of ocular morbidity

Of 33,549 children enrolled, 1836 children (5.47%) had some sort of ocular morbidity, which was confirmed by the

Table 1 – Background characteristics of children identified with ocular morbidity by community health workers (CHWs).

Characteristic	n (%)[a]
All screened children	
No. of children (aged ≤15 years) screened (N)	33,549
Mean age in years (±SD)	9.8 ± 4.3
Age in years	
<5	12,581 (37.5)
≥5 to 15	20,968 (62.5)
Sex	
Male	16,942 (50.5)
Female	16,607 (47.5)
Children identified with ocular morbidity	
Mean age in years (±SD)	8.4 ± 4.7
Age in years	
<5	530 (28.1)
≥5 to 15	1357 (71.9)
Sex	
Male	991 (52.5)
Female	896 (47.5)
Child's education (n = 1357; children aged ≥5 years)	
No schooling	88 (6.5)
1–5 years	517 (38.1)
6–10 years	752 (55.4)
Mean household income/month in Bangladeshi Taka (±SD)[b]	12,216 ± 8284
Household income in **Bangladeshi Taka**	
≤5000	126 (6.7)
5001–10,000	897 (47.5)
10,001–20,000	864 (45.8)
Resident status	
Permanent of Keraniganj	643 (34.1)
Tenant (rural-to-urban migrant)	1244 (65.9)
Current dwelling status	
Living in slums	817 (43.3)
Non-slum households	1070 (56.7)
Parental education (father and mother)	
No schooling	472 (25.0)
1–5 years	638 (33.8)
6–10 years	716 (37.9)
>10 years	61 (3.2)
Occupation of parentsrowhead	
Day labor/rickshaw puller	804 (42.6)
Small business	259 (13.7)
Public/Private service	262 (13.9)
Garments worker/factory worker	379 (20.1)
Other	183 (9.7)

SD, standard deviation.
[a] Unless stated otherwise.
[b] One US$ = 82.7 Bangladeshi Taka.

ophthalmologists. The ophthalmologists excluded only 51 children (2.7%) as having no ocular problems during the detailed examination; the other 97.3% (1836 out of 1887) of children identified with ocular problems by the CHWs had some form of ocular morbidity. The most commonly observed ocular morbidities were refractive errors (3.24%; 95% CI = 3.11–3.45; defined as a VA of ≤6/12), allergic eye conditions (1.15%; CI = 0.74–1.27), nasolacrimal duct obstruction (0.52%; CI = 0.25–0.74), ptosis (0.15%; 95% CI = 0.11–0.19), and squint (0.13%; 95% CI = 0.10–0.17). The refractive error was significantly higher among older children and girls.

When defining blindness as a VA of <6/60 and visual impairment as <6/18, we found that the prevalence of blindness and visual impairment among the children in the study were 0.060% (95% CI = 0.03–0.11) and 0.086% (95% CI = 0.03–0.16), respectively. Among 20 children identified as blind, 11 were aged <5 years and nine were aged 5–15 years ($\chi^2 = 7.25$; $P = 0.007$). The key causes of blindness among the children in this study were corneal opacity, congenital eye anomaly (including cortical blindness), cataract, retinopathy of prematurity (ROP), and retinoblastoma. Table 2 illustrates the patterns of ocular morbidity in the study group.

Factors associated with ocular morbidity

Among the total sample (n = 33,549), 1836 children (5.47%; 95% CI = 4.86–6.32) who were examined by the ophthalmologists had at least one type of ocular morbidity in at least one eye. Only 1.2% (95% CI = 1.0–2.1) of the children enumerated had multiple ocular morbidities.

Table 3 illustrates the results of univariate analysis examining the association between the prevalence of ocular morbidity (at least one morbidity in at least one eye) and sociodemographic characters of the children and their parents (sex, age, education, income, and occupation). The prevalence of ocular morbidity was nearly two times higher in older children compared with younger children (odds ratio [OR] 1.8; 95% CI = 1.3–2.4; $P < 0.1$) and among children with low parental education compared with those with higher parental education (OR = 0.7; 95% CI = 0.5–1.3; $P < 0.01$). Other sociodemographic variables found to be statistically significant were male sex, low income of the parents, and slum dwelling status of the households.

Gender differences in treatment and referral

Table 4 highlights gender differences in screening, referral, and treatment. In this study, the majority of the children with ocular morbidity (52.5%) and blindness (60%) were male. All children identified with ocular morbidity (n = 1887) visited the base hospital for initial examination by the ophthalmologists, and 1786 of them received free treatment (53% male; 47% female) for minor eye problems, including refractive error correction; however, only 85.1% of 101 children (51.5% male; 48.5% female) who were referred to NIO-H for further evaluation and treatment actually attended. Fewer girls (71.4%; 35 of 49) than boys (98.1% 51 of 52) visited the referral hospital (NIO-H) for care. Most of these children were either eligible for invasive investigations or surgical interventions. Among those who received free surgeries (n = 34) at NIO-H, 67.7% were boys and 32.3% were girls.

Referral pattern and self-referral

Data collected from NGO Hospital's database revealed that yearly caseload of pediatric eye patients increased from 683 at baseline (July 2015 to June 2016) to 2379 during the intervention period (July 2016 to June 2017) [this data excluded 1887 cases covered through this study]. Most of these cases were either referred by CHWs (73%) or self-referral (27%). Furthermore, referral from the base hospital to NIO-H increased from

Table 2 – Distribution of childhood eye diseases as diagnosed by pediatric ophthalmologists.

Diagnosis	Age (years) [n]		Total (n = 33,549) [n]	Prevalence [% (95% CI)]	Prevalence [n/1000 children screened]
	<5	≥5–15			
Total eye problem identified by CHWs	530	1357	1887	5.63 (5.27–6.16)	56.25
Prevalence of ocular morbidity as confirmed by pediatric ophthalmologists	499	1337	1836	5.47 (4.86–6.32)	54.73
Minor ocular trauma with no visual impairment	29	40	69	0.21 (0.17–0.25)	2.06
Allergic eye condition/conjunctivitis	183	202	385	1.15 (0.74–1.27)	11.48
Refractive errors (VA ≤6/12)[a]	134	952	1086	3.24 (3.11–3.45)	32.37
Ptosis	27	23	50	0.15 (0.11–0.19)	1.49
Squint	20	22	42	0.13 (0.10–0.17)	1.25
Nasolacrimal duct obstruction	91	82	173	0.52 (0.25–0.74)	5.26
Retinitis Pigmentosa	0	2	2	0.01 (0.00–0.03)	0.06
Ocular lipodermoid cysts/solid dermoid tumors	2	3	5	0.015 (0.01–0.04)	0.15
Amblyopia	2	2	4	0.012 (0.01–0.03)	0.12
Prevalence of potential blindness as identified by pediatric ophthalmologists (VA <6/60)	11	09	20	0.060 (0.03–0.11)	0.60
Cataract	2	1	3	0.01 (0.00–0.04)	0.09
Corneal opacity	4	5	9	0.03 (0.01–0.05)	0.27
Retinopathy of prematurity	1	0	1	0.00 (0.00–0.03)	0.03
Retinoblastoma	3	0	3	0.01 (0.00–0.05)	0.09
Congenital eye anomaly	1	3	4	0.012 (0.01–0.04)	0.12
No eye problems found by ophthalmologists	31	20	51	0.15 (0.10–0.21)	1.52

CHW, community health worker; CI, confidence interval; VA, visual acuity.
[a] Includes children who were wearing glasses before the study enrollment.

Table 3 – Univariate regression analysis examining the association between prevalence of ocular morbidity in at least one eye and demographic characteristics of children and their parents.

Variables (n = 1836)	OR (95% CI)	P-value
Age ≥5–15 years [r = age <5 years]	1.8 (1.3–2.4)	<0.01
Male [r = female]	1.4 (1.1–2.2)	<0.05
Child's education [r = 0 years of schooling]	1.0 (0.8–1.4)	0.73
Parental education [r = 0 years of schooling]	0.7 (0.5–1.1)	<0.01
Monthly household income ≤10,000 Taka [r = >10,000 Taka][a]	1.5 (1.1–1.9)	0.04
Urban resident [r = rural-to-urban migrant with in temporary settlement]	1.2 (1.0–2.5)	0.09
Lives in slum [r = non-slum households]	1.3 (1.1–2.3)	<0.05
Occupation: manual worker [r = non-manual work]	1.1 (0.9–2.7)	0.06

CI, confidence interval; OR, odds ratio; r, reference category.
[a] One US$ = 82.7 Bangladeshi Taka.

38 cases at baseline (July 2015 to June 2016) to 453 cases during the intervention period (July 2016 to June 2017) [this excluded 101 referral cases covered through this study].

Discussion

This is the first large-scale population-based study in Bangladesh that has investigated the prevalence of childhood ocular morbidity using data collected through a two-stage cluster sampling strategy. The field activities were carried out by CHWs of an NGO alongside their regular health interventions. Data indicated that CHWs were able to approach all targeted households and identified the majority of children who had ocular problems in the study community. The possible explanations for this high participation rate may be as follows: (i) CHWs used in this study were involved in community mobilization and engagement activities for other health interventions; (ii) CHWs were accepted and trusted by the community; and (iii) CHWs were motivated to serve their own community. By engaging the community with the intervention and building trust and approval, CHWs can create an enabling environment to work with both the research team and the target community.[30] Thus, CHWs in this study were well positioned to generate social networks within their communities, including trust, which they utilized to create awareness and link communities with service facilities aimed at reducing the burden of avoidable eye diseases.[31] Data also suggest only 2.7% of all cases identified by CHWs were excluded as having no ocular problems by the ophthalmologists during examination at the base hospital. The study demonstrated that it is feasible to implement an integrated eye health intervention research utilizing ongoing infrastructure and facilities of the Government and NGOs in a resource-limited setting.

This study revealed that the overall prevalence of ocular morbidity was 5.47% among all children aged ≤15 years and 3.97% among children aged <5 years. Our findings differ from those of other population-based studies in Southeast Asia, where the prevalence usually accounted for 2.7–2.8%.[11,32] However, a few school-based studies in Bangladesh and other developing countries have reported ocular morbidity in children (aged 5–16 years) varying between 16.9% and 31.6%.[21,33,34] This study investigated the prevalence of ocular morbidity involving a larger sample of peri-urban population

Table 4 – Sex segregated data on screening, treatment, and referral.

Indicators	n (%)		
	Total	Male	Female
Children (aged ≤15 years) screened by CHWs	33,549	16,271 (48.5)	17,278 (51.5)
Children identified by CHWs with ocular morbidity	1887	991 (52.5)	886 (47.5)
Prevalence of blindness	20	12 (60.0)	8 (40.0)
Children referred to NGO hospital and examined by pediatric ophthalmologist from NIO-H	1887	991 (52.5)	886 (47.5)
Children received conservative treatment including RE correction at NGO hospital	1786	947 (53)	839 (47)
Children identified for further treatment and referred to NIO-H	101	52 (51.5)	49 (48.5)
Children attended and pursued further care from NIO-H	86	51 (98.1)	35 (71.4)
No. of successful surgeries performed at NIO-H	34	23 (67.7)	11 (32.3)
At least 3 follow-up visits by CHWs at households where patients received care from NIO-H	86 (100)	NA	NA
Children received postsurgery follow-up visits at NGO hospital by eye specialist	34 (100)	NA	NA
No. of cases (children aged ≤15 years) at NGO hospital (July 2015–June 2016)	683	NA	NA
No. of cases (children aged ≤15 years) at NGO hospital (July 2016–June 2017) [excluding the cases covered through study]	2379	NA	NA
No. of cases referred to NIO-H (July 2015–June 2016)	38	NA	NA
No. of cases referred to NIO-H (July 2016–June 2017) [excluding the cases covered through study]	453	NA	NA

CHWs, community health workers; NA, not available; NGO, non-governmental organization; NIO-H, National Institute of Ophthalmology and Hospital; RE, refractive error.

and demonstrated a strong association between prevalence of ocular morbidity and age of the children. At the univariate level, children aged 5–15 years were nearly twice as likely to have ocular morbidity compared with children aged <5 years. We also observed a clear link between ocular morbidity and parental education. After controlling for potential confounders, age and parental education remained the strongest associated factors for ocular morbidity.

We also used our data to explore the prevalence and potential causes of childhood blindness. As the prevalence of blindness in children is much lower than in adults, a larger sample size of children was needed to provide an accurate estimation.[12] Data suggest that the prevalence of blindness among children aged ≤15 years was 0.60 per 1000 children, indicating there was a relatively small number of children who were blind in our study community (this is less than half of the previously predicted prevalence at 1.5 per 1000 children).[9,10] A very similar prevalence was reported in other studies in rural and urban settings in Southeast Asia.[11,13,14] Our results also indicate that a much higher proportion of children aged <5 years were blind compared with children aged 5–15 years ($\chi^2 = 7.3$; $P = <0.01$). The key causes of blindness among children were corneal opacity, congenital eye anomaly (including cortical blindness), cataract, and retinoblastoma; this finding is consistent with other studies from developing countries.[11,13,22] Given the extent of ocular morbidity and blindness among younger children, awareness campaigns targeted at children of both preschool and school age in Bangladesh are warranted to ensure early detection and access to timely treatment. ROP was not found to be a major cause of blindness, although the possibility of developing ROP is likely to be high in large cities such as Dhaka.[22]

In contrast to the results of some studies,[11,35] but in line with others,[22,36] our findings demonstrate a significantly higher prevalence of childhood ocular morbidity and blindness in boys compared with girls.

However, the relatively small sample size has to be kept in mind when interpreting the blindness data. Our data also revealed a higher prevalence rate among children from low-income families and among those who were living in slums, but this association was found to be insignificant after controlling for all confounders.

A notable gender difference in care-seeking behavior was also observed among those who were referred to NIO-H for further evaluation and treatment. Fewer girls among those who were eligible for further evaluation sought care from the referral hospital. Consistent with the findings of other studies, the health-seeking behavior data confirmed that parents sought health care for ocular problems more frequently for boys than for girls.[22,36] In a setting such as Bangladesh, the reason behind this may be because of the fact that parents are more willing to invest their limited resources in the welfare of sons rather than daughters.[22] Having said this, it should be noted that the parents of girls aged >10 years were more likely to seek ocular health care compared with younger girls. This demands further exploration and special attention of the policymakers and program implementers to ensure equitable access to health care.

Refractive errors were the most common morbidity found in this study (3.24%), which is more than other population-based studies conducted in resource-poor settings[11,37] and lower than a study conducted in urban India.[13] These data also indicated that refractive error, which can be easily treated with spectacles, was responsible for more than half (58%) of the ocular morbidity among children; this has also been documented as a common ocular morbidity among preschool and school children in other studies.[21,38–41] Refractive error affects childhood development, given that most of the learning in children is sight dependent.[28] In the absence of regular preschool or school eye-screening tests for refractive errors, many children with refractive errors go unnoticed in Bangladesh. Our data revealed that the prevalence of refractive errors among school children (aged 5–15 years) was higher than preschool children (aged <5 years). The higher rate reported in older children could be because of better detection of visual problems by older children, suggesting a lack of detection by parents and teachers at younger ages. Furthermore, significantly higher refractive errors were seen in girls, which is similar to a previous study, suggesting that young females tend to report visual problems more than males.[42] School health programs that regularly screen for refractive errors and refer children for appropriate eye care can prevent poor performance in school and the progression of visual impairment.[38–41] Considering that refractive error is a significant cause of visual impairment among school children,[38] health education and screening of school children can play an important role in detecting refractive errors. Therefore, students, parents, and teachers must be educated about signs and symptoms of refractive errors to ensure early detection and correction with spectacles and prevent progression of visual impairment.

Strengths and limitations

The strengths of this study include a community-based approach that yielded a high response rate, in addition to a large sample size of children from the communities (irrespective of their economic and demographic background), use of a two-stage cluster sampling procedure, and ascertaining ocular morbidity with a population-based approach using culturally standardized questionnaires.

Implementing this project without any research funding was a real challenge. However, this was possible because of the commitment of the Government institutions and participating NGOs to complete this project through the platform of ongoing programs. Moreover, a group of committed program managers, researchers, and ophthalmologists took the challenge and provided voluntary services to implement the project outside of their busy schedules.

Data collection was limited to one small geographic area of Dhaka. This may not represent the Dhaka division or country-level prevalence and thus limits the generalizability of our results. However, a subdistrict level prevalence survey may help in formulating appropriately targeted measures and future eye care programs in Bangladesh. Because data were cross-sectional, temporality and causality cannot be established. The approach of not using optometrists or ophthalmologists at the first level of screening might have resulted in missing some delicate ocular problems, such as visual inattention, and there might have been an under-estimation of the prevalence of some rare conditions. However, it is worth mentioning that Bangladesh suffers from an acute shortage of qualified health workforce; thus, we considered that using trained CHWs of ongoing programs for community-based screening purposes was a more feasible and cost-effective approach for community intervention research.

Conclusions

Our study demonstrates that although overall ocular morbidity is not uncommon among children in Bangladesh, childhood blindness is very rare and even lower than previous estimations for Bangladesh. This study provides data on the prevalence and determinants of childhood ocular morbidity in Bangladesh. The findings of this study have major implications for both public health programming and clinical practice in Bangladesh, where recognition and identification of childhood ocular problems are low, and improving identification rates is a challenge because of poorly developed urban healthcare systems. Using a community-based approach and training the CHWs on childhood eye problems with simple techniques and materials and providing them with appropriate tools for awareness intervention and primary screening of eye disorders could play a crucial role in early identification of problems among children. This could also help improving health-seeking behaviors and self-referral and strengthening the referral mechanism and care pathway as a whole, thus bringing positive change in the community.

In the context of Vision 2020 and Universal Health Coverage, it is crucial that in addition to providing eye care services, an appropriate service delivery model should include the provision of community mobilization for increased awareness about early detection of ocular problems among children and prevention of childhood eye diseases, as well as an effective referral mechanism linking communities with facilities for accessing client-centerd services.

Author statements

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Ethical approval

Ethical approval for the study was granted by the James P Grant School of Public Health Ethics Committee at BRAC University, Dhaka, Bangladesh. Written informed consent for participation was obtained prior to each interview from the guardian/parent of each child. All procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional and/or national research committee. All children identified with ocular problems were referred, and treatable conditions received free treatment.

Competing interests

On behalf of all authors, the corresponding author confirms that there are no conflicts of interest.

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Appendix A. Supplementary data

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