



Spectacle compliance among school children in Malawi, Nigeria and Pakistan



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Brien Holden Vision Institute Team

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Glossary of Terms

Astigmatism – a deviation of the eye or lens shape from spherical curvature, which results in distorted images, as light rays are prevented from meeting at a common focus. This can be corrected with cylindrical lenses in spectacles or contact lenses.

Emmetropia – a normal eye condition where objects at distance appear clear when the eye is in a relaxed state. This is the result of images being focused directly on the retina.

Hyperopia – also referred to as long-sightedness is a condition where there is difficulty focusing on objects at close range and hence near objects may appear blurred, or in children, it can cause eye strain, headaches and/or an aversion to near work. This is the result of images being focused behind the retina instead of on the retina.

Myopia – also referred to as shortsightedness or near-sightedness is a condition where objects at close range appear clear and those in the distance appear blurred. This is the result of images being focused in front of the retina instead of on the retina.

Refractive Error – a group of eye conditions including myopia, hyperopia and astigmatism. Blurred and/or distorted vision results from an unfocused image falling on the retina. Refractive errors are measured in diopters. They are the most common cause of vision impairment in children and adults and can be corrected by spectacles or contact lenses.

Spectacle compliance – Spectacle compliance is calculated as (total wearing frequency observed by teacher/total expected wearing frequency)*100%.

Visual acuity (VA) – relates to clarity of vision and measured by a person's ability to discern letters on a test chart at a given distance. Normal VA is considered to be 20/20 (test distance measured in feet) or 6/6 (test distance measured in meters). A person with a VA of 6/12 means the object or letter size resolved by the person at 6 meters away would be resolved by a 'normal' sighted person at 12 meters away.

Blindness – Presenting vision worse than 3/60 in the better eye.



List of Abbreviations

95% CI	95% confidence interval
DC	Diopters cylinder
DCEC	District Comprehensive Eye Care
DS	Diopters sphere
ICD	International Classification of Diseases
LogMAR	Logarithm of Minimum Angle of Resolution (a unit for specifying VA)
n	Sample size population
OCO	Ophthalmic Clinical Officer
QoL	Quality of Life
RE	Refractive error
RESC	Refractive Error Studies in Children
RMS	Ready-made spectacles
SD	Standard deviation
SGD	Sustainable Development Goals
UNCRC	United Nations Convention on the Rights of the Child
URE	Uncorrected refractive error
VA	Visual acuity
VI	Vision impairment
WB	World Bank
WHO	World Health Organization

Executive Summary

WHO estimates that there are 19 million children with vision impairment.

Background

Children, in today's rapidly changing world, have to face many diverse socio-cultural challenges almost every day. For them, coping with the ever-changing environment is a huge task that must be addressed through strategies that protect their civil, social, health and cultural rights. This has brought a positive global shift in thinking about children and their lives in diverse social and cultural settings with 196 countries being parties to the Convention on the Rights of the Child (UNCRC).¹ The right to basic health services, being one of the basic rights of children, is now also aligned to the Declaration of Alma Ata – the international framework of standards, principles and targets – that identified primary health care as the key to the achievement of the goal "Health for All".

The focus of the Sustainable Development Goals (SDG) highlights the direct impact that educational attainment has on future indicators for individual and national economic growth, individual health outcomes, and, importantly, on the health and educational outcomes of the children.² Child eye health is an important issue due to the impact that poor vision can have on a child's educational attainments and social development. The World Health Organization (WHO) estimates that there are 19 million children with vision impairment and of these, an estimated 12 million (63%) is due to uncorrected refractive error (URE).³ Having a child left uncorrected may negatively impact an individual for life. Studies have shown that children with uncorrected refractive error can have lower self-esteem⁴ and poorer literacy scores.⁵⁻⁸

Schools are effective settings to implement strategies for child eye health in the prevention of vision impairment due to uncorrected refractive error as the majority of children can be reached on a regular basis in a structured environment.⁹ School-based vision-screening programs may include spectacle provision, while other settings require a referral to external eye health services. Therefore, the rates of compliance with spectacle use (wearing spectacles at the time of assessment) in children vary in different countries. As evidence-based resource allocation decisions demand evidence from various cultural settings, it is important to understand the determinants of spectacle compliance among schoolchildren from a local setting in order to take necessary steps for enhancing compliance to spectacle use. Malawi, Nigeria and Pakistan are areas with different demographics, community attitudes and varying service availability.

Currently, there is limited information regarding spectacle-use compliance and barriers of non-compliance. Therefore, evidence is required to determine those measures that can assist in improving compliance outcomes from school-based eye health programs.

Objectives

This was a longitudinal, observational study, conducted in Malawi, Nigeria and Pakistan, designed to determine:

- The prevalence of vision impairment and uncorrected refractive error among schoolchildren.
- Spectacle compliance at three months among school going children with significant refractive error.
- Identify barriers to spectacle compliance in school going children.

Methodology

The study was divided into two phases. The three countries were chosen to represent East Africa (Malawi), West Africa (Nigeria) and South East Asia and East Mediterranean (Pakistan) regions. Schools were chosen based on their availability for data collection during the study period. In Phase 1, children who were enrolled and studying in primary, lower and upper secondary schools were selected for participation. In Phase 2, eight (8) to 16 year-old children who were identified as having failed the vision screening ($VA < 6/9$ in any eye) in Phase 1 with significant uncorrected refractive error ($> -0.25DS$ and $> +1.50DS$, $> -0.50DC$ in astigmatism) and no other ocular morbidities were included.

In Phase 1, vision screening was conducted to determine the number of children with vision impairment and refractive error. Children who were identified as failing the vision screening ($VA < 6/9$ in any eye), children who had significant uncorrected refractive error ($> -0.25DS$ and $> +1.50DS$, $> -0.50DC$ in astigmatism) and children with no other ocular morbidities were given a full refraction, with a range of children's frames to choose from and provided with a pair of spectacles free of charge. A proportion of these children were then included in Phase 2.

In Phase 2, a longitudinal study design was employed. The class teacher was advised to discreetly monitor spectacle use of the children twice a day, once during

the second period in the morning and once in the last two periods before school ends, and documented it in a recording sheet. These children were followed up for three months. At the third month, the team conducted a surprise check to determine the spectacle compliance of the children and the reasons for non-compliance were also determined. All parents of the children were then contacted (approximately three months after the vision screening) for a brief telephone or face-to-face interview to understand the barriers to uptake of eye care services.

Results

Malawi

The prevalence of children with vision impairment (failing VA at 6/9) and refractive error was 2.2% and 3.4%, respectively. The average observed spectacle compliance among the 70 children followed up was 53.5% (SD ± 29.2%). Of the children not wearing spectacles at all, 47.1% responded that they were not wearing their spectacles because their parents disapproved of their spectacle wear. Additional reasons were that they did not see well with their spectacles or experienced headaches after wearing the spectacles (both 35.3%). About 40% of the children also responded that they were wearing their spectacles less than the required time because they did not think that they needed to wear spectacles all the time (41.7%). About 40% of children (wearing or not wearing spectacles) also reported that their parents disapproved of them wearing their spectacles all the time and 79.4% of parents said that they did not think their children needed to wear them all the time.

More than 80% of the parents/guardians responded that they were willing to pay for the next eye examination and a new pair of glasses when required. The main reasons for their willingness were that they were concerned about their children's vision; they wanted their children's vision to be assessed and believed that correction can be provided to the children to improve their vision. The parents/guardians who were unwilling to purchase replacement spectacles responded 'unaffordability' for both eye examination and glasses was their main reason.

Nigeria

The prevalence of children with vision impairment (failing VA at 6/9) and refractive error was 11.0% and 5.7%, respectively. The average observed spectacle compliance among the 219 children followed up was 59.2% (SD ± 32.4%) with 60.2% (n=132) of the subjects who were observed to wear spectacles more than half the time.

Of the children not wearing spectacles at all (n=36), 55.5% reported lost or broken spectacles. Of the children who were only wearing spectacles

occasionally, 43.2% children responded that they did not feel the need to use them all the time and 22.1% felt uncomfortable or disliked wearing their spectacles. Another 45.7% of the children felt that wearing spectacles makes them look like a nerd/geek. The majority of parents and guardians responded that they were willing to pay for the next eye examination and willing to buy their children a new pair of glasses if required.

Pakistan

The prevalence of children with vision impairment (failing VA at 6/9) and refractive error was 5.4% and 5.3%, respectively. There was a significantly higher number of children 12 years and older with myopia ($p < 0.001$) and 2.4 times more girls who had myopia compared to boys ($p < 0.001$). The average observed spectacle compliance among the 98 children followed up was 68.9% (SD ± 37.5%) with 73.5% (n=72) of the subjects wearing their spectacles for more than 50% of the observed time. The majority of the children responded that they were not wearing spectacles because their spectacles were broken or they felt uncomfortable wearing their spectacles. The main reasons reported by children wearing spectacles occasionally or part-time were that they were teased by friends or disliked wearing spectacles.

The main reasons for guardian's willingness to pay for an eye examination or purchase spectacles were that they were concerned about their children's vision and that it was for the betterment of the child's health. Parents and guardians want their children to have good vision. Those who reported unwillingness to pay for both eye examination and glasses quoted 'unaffordability' as the main reason.

Discussion

The prevalence of vision impairment due to refractive error was highest in Nigeria followed by Pakistan then Malawi. Although this might suggest vision screenings in school-based services should first be targeted in Nigeria, the schoolchildren participating in this study were from secondary schools and generally older. Considering myopia increases with age particularly in the teenage years, these results might have skewed the outcomes. It should be noted that 8.9% of schoolchildren aged 12 years in Pakistan as opposed to 6.0% in Nigeria had refractive error.

The participating children in this study had relatively high spectacle compliance compared to previously reported studies. We suspect that this may be due to relatively high literacy levels in the study communities and a range of appropriate frames to choose from. However, non-compliance is still an issue in these communities as in Malawi and Nigeria 40% of the children were non-compliant.

Guardians in both our studies in Malawi and Pakistan quoted unaffordability as the main reason for unwillingness to have their children's eyes examined and a new pair of glasses purchased when required. In both Malawi and Pakistan, the cost of a pair of spectacles for children is equal to, or greater than the average annual out of pocket expenditure for health care. In Nigeria, practically all parents reported that they are willing to purchase spectacles for children.

Conclusion

We found relatively high levels of spectacle compliance rate in our samples and identified the reasons of non-compliance when compared to previous studies. However, there is still a significant percentage of children who were non-compliant in our study. Unless an effective eye health awareness strategy is in place to sensitize the community, parents and children on the need to correct refractive error and the negative impact of non- and under-correction of refractive error, the barriers towards compliance will not be overcome. The high spectacle compliance in the three countries were related to a short period of follow up (three months). This may be lower if we extend the follow up period and if there is no awareness strategy in place to sustain the wearing compliance of the children.

Recommendations

Policy

- School health should be a part of broader education policy and offered by a designated department in the Ministry of Education, which is responsible for the role out of various components of school health in collaboration with other line ministries including health, water and sanitation, food and rural development.
- Budget allocation by line ministries for teachers training, provision of refraction and spectacle services.
- The school health should be an integrated part of a comprehensive education package that includes health, promotion, prevention, treatment and referral. It should also include strategies to support children with disabilities.

Service Delivery

- Spectacles should be more accessible and affordable through strategies such as different pricing instalment plans or cross-subsidization plans. However, there is crucial need to sensitize the community with the right information on the availability of the free eye examination provided in the public health facilities and the affordable spectacles available.

- Ready-made spectacles (RMS) should be available to improve access and affordability.
- The spectacles should conform to the global safety standards to withstand wear and tear and handling in outdoor activities like sports.

Infrastructure and Technology

- An attractive but reasonably priced frame and lenses should be available through the development of public sector or optical social enterprises at district level.
- Basic refraction and dispensing equipment should be available and functional as part of a district comprehensive eye care program.

Human Resource Development

- There is a need to train the teachers in basic vision assessment and classroom management of children with Refractive errors.
- Need to provide refresher training to ophthalmic clinical officers/optometrists in pediatric refraction.

Health Management Information Systems

- Proper maintenance of eye records of children with refractive errors at the school and the hospital level management information system is needed.

Advocacy and Networking

- Advocacy with the Ministry of Education and Health to integrate eye health in the school health program is necessary. It is crucial that child eye health is recognized as a priority by the government and adequate resources are allocated for the development, deployment and provision of eye care services to children.
- Advocating to the education department to include eye health screening in the health checks before school enrolment can help to identify children with vision problems and treat them timely.
- Interventions, such as awareness strategy should be implemented, to determine if it improved spectacle compliance among the wearers.
- Designated and agreed roles and responsibilities of stakeholders including Ministry of Education, Ministry of Health, Department of Education and Community and consumer based organization is needed.
- Health promotion aimed at girl children to promote spectacle correction, who are currently experience higher rates of refractive error and myopia should be developed and implemented.

Introduction

Children with uncorrected refractive error can have lower self-esteem⁴ and poorer literacy scores.⁵⁻⁸

Problem

The association between correcting refractive error and improved academic performance have been positively demonstrated.^{5,10,11} While other studies have shown that children with uncorrected refractive error can have lower self-esteem⁴ and poorer literacy scores,⁵⁻⁸ schoolchildren in various areas worldwide continue to have low rates of spectacle compliance. Therefore, efforts are needed to improve spectacle compliance rates that can be supported with evidence on factors that increase spectacle compliance rate and barriers for non-compliance for children. As evidence-based resource allocation decisions demand evidence from various cultural settings, it is important to understand the determinants of spectacle compliance among schoolchildren from the local setting in order to take the necessary steps for enhancing compliance in spectacle use.²

Relevance and importance

The focus of the Sustainable Development Goals (SDG) highlights the direct impact that educational attainment has on future indicators for individual and national economic growth, individual health outcomes, and, importantly, on the health and educational outcomes of the children.² The association between vision impairment and education attainment have been linked, and the World Health Organization (WHO) estimates that there are 19 million children with vision impairment (using ICD-10 definitions).¹² Of those with vision impairment, an estimated 12 million (63%) is due to uncorrected refractive error¹ suggesting eye health is important in child development.

Previously, child eye health programs have not received the same attention as adult-focused interventions, and most child eye health programs have focused primarily on childhood blindness. In the last five years, there has been a gradual shift towards emphasizing child eye health, involving vision impairment due to refractive error. This is due to better epidemiological data available on the prevalence of vision impairment due to uncorrected refractive errors, and sufficient information available to predict significant increases in refractive errors globally.¹³ Sustained advocacy by various groups and professional forums has also contributed to this realization.

Programs need to be planned with a range of stakeholders, including government, teachers, parents, and children, ensuring that children's voices are heard and given due weight. Programs need to be accessible to all children, including vulnerable groups such as children with disabilities, girls and children who are out of school. Furthermore, programs need to be well integrated into the fabric of society that includes the community, broader health and education systems, human resource development and health education components. This research aims to further contribute evidence to planning future school-based health programs involving vision screenings.

Literature Review

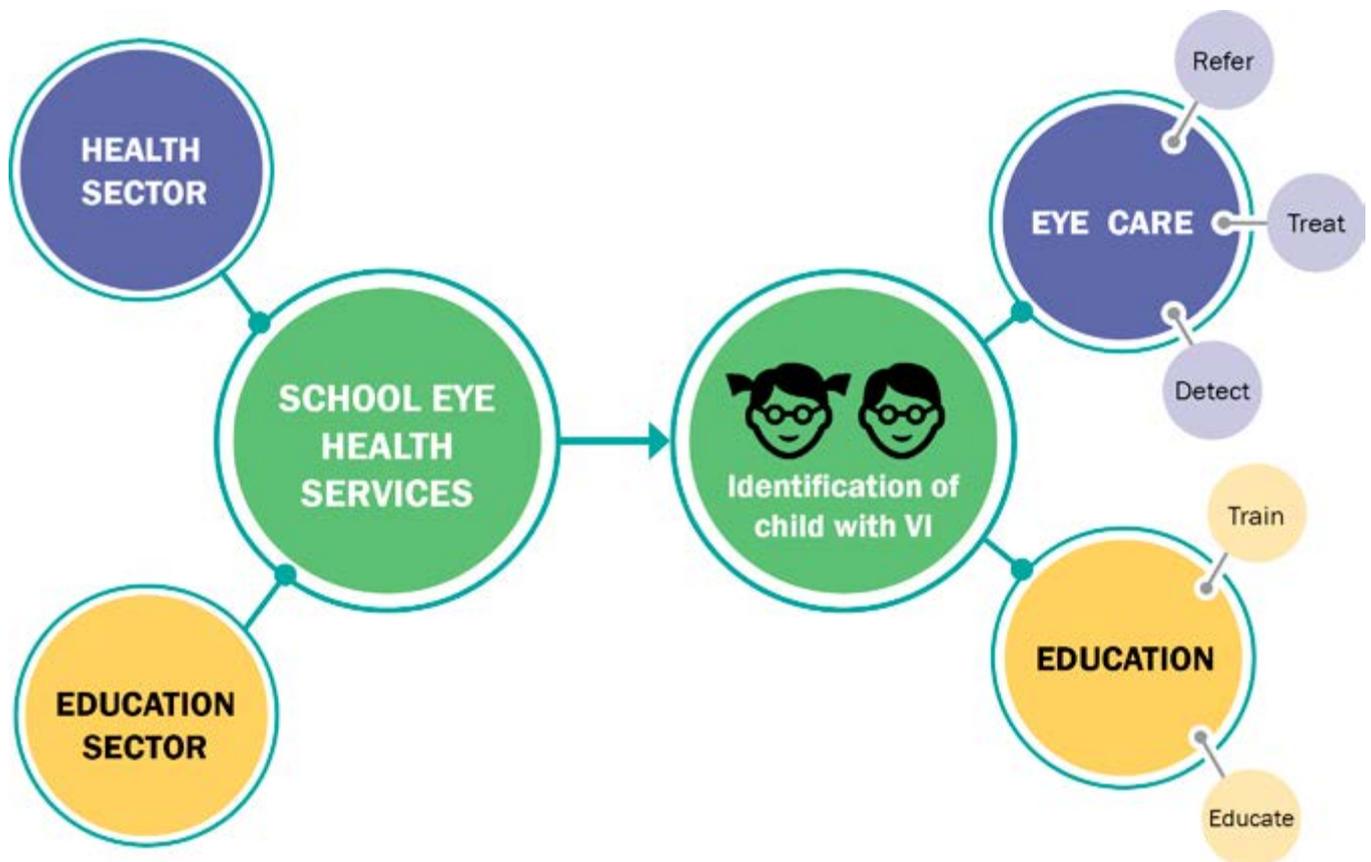
Uncorrected refractive error is a leading cause of visual impairment worldwide.³

School-based health programs are health services provided on school premises either by on-site or visiting health practitioners. Schools are one of the most effective settings to implement strategies for the prevention of health issues as the majority of children can be reached on a regular basis in a structured environment.⁹ Uncorrected refractive error is a leading cause of visual impairment worldwide.³ A child with vision impairment might be identified through school-based screening or by an eye care program. Figure 1 demonstrates the close linkage needed between the health and education sectors to effectively deliver eye health services to the schoolchildren. It also demonstrates that school eye health acts as a bridge between the eye care and education sectors.

Although vision screenings have been one of the top five interventions in schools-based health programs,⁹ spectacle provision are included in some settings while other settings depend on a referral process to external health services. Thus, the rates of spectacle uptake and use in children are likely to vary across different settings.¹⁴⁻¹⁷

In Rawalpindi District, Pakistan, 59% of school going children aged 11-16 years were not compliant with full time spectacle wear. Anwar et al.¹⁸ reported contributing factors included younger age group (11-13 years), hyperopia or astigmatism, being a part of a nuclear family and having non-educated fathers, to be associated with poorer compliance.

Figure 1: Depiction of how child eye health can be integrated in school health services



The reported reasons for non-compliance with spectacle wear included a dislike of wear, peer pressure and broken or lost spectacles. Despite having interesting outcomes, this was a cross-sectional study where students were not observed over time regarding spectacle wear time and details on how compliance was assessed is ambiguous.

In Nigeria, the prevalence of vision impairment (visual acuity $<6/9$) in secondary schoolchildren was estimated to be 5.2%, with a significantly greater proportion being female. Of the 61 students examined to have refractive error, less than 10% presented with spectacle wear. All those wearing spectacles were male, from private schools and were more likely to do so if both parents wore spectacles. The most commonly reported reasons by schoolchildren for non-compliance included "I don't know I need it" and lack of affordability.¹⁹ Other reported perceptions of spectacle wear from undergraduate students from Nigeria include that they fear being mocked by peers, perceived people with glasses as visually handicapped or that they were meant for old people.²⁰ Despite these suggestions of poor compliance and attitudes towards spectacle wear, there has been no investigations into spectacle wear over time.

Similarly to Nigeria, there is currently limited published information regarding schoolchildren and spectacle compliance in Malawi. Only a study of schoolchildren with low vision in integrated schools reported 37% were compliant with spectacle wear.²¹ However, no information regarding the reasons behind lack of compliance were explored.

In a study in Oaxaca, Mexico, Holguin et al.¹⁴ recruited 493 schoolchildren, aged 5 to 18 years to determine the prevalence and determinants of compliance with spectacle wear among schoolchildren who were provided spectacles free of charge. It was found that only 13.4% of the sample were using spectacles as intended. An additional 34% had the spectacles with them but were not wearing them.¹⁴ The authors pointed out that although spectacles were free of charge, compliance with spectacle wear was low, particularly among older, urban children. This is of particular concern considering prevalence of myopia is highest among older children living in an urban setting.²² The three main reasons given by children for not wearing spectacles were that they were concerned or teased about their appearance of wearing spectacles, forgetting their spectacles at home on the day of inspection, or only used their spectacles occasionally or at special times.¹⁴

In India, Gogate et al.²³ studied the compliance of spectacle wear among 1,018 rural schoolchildren in Pune, Maharashtra after 6 - 12 months of being

provided free spectacles as part of the sarva siksha abhiyan (education for all scheme). Spectacle use was 29% and was associated with the magnitude of refractive error, father's education, female sex and visual acuity of the better eye and area of residence. Similarly to Holguin et al.,¹⁴ the main reasons for non-wear were forgetting spectacles at home and being teased about wearing spectacles.

Messer et al.¹⁵ investigated factors associated with spectacle wear in a group of 247 primarily Native-American children provided spectacles free of charge through a school-based vision program and found that spectacle wear was 33%. The authors concluded that despite being provided with two pairs of spectacles, loss and breakage were the most commonly reported reasons for not wearing spectacles. Furthermore, the best predictive factor for determining whether participants were wearing spectacles was their uncorrected acuity.

When comparing whether free spectacles or only a prescription for spectacles influences wearing rates among 6,940 Tanzanian secondary students with un/under corrected refractive error (RE) in a two-arm trial, it was found that compliance ranged from 26% – 47%. The authors raised doubts about the value of vision-screening programs in Tanzanian secondary schools. Policy decisions on school vision screening in middle-and-low income countries should take account of the cost effectiveness as well as competing demands for scarce resources.²⁴

Lastly, Keay et al.¹⁶ examined factors influencing adherence to spectacle wear and perceived value within a prospective one-month trial of ready-made and custom spectacles in school-aged children with uncorrected refractive error in urban China. It was found that most students planned to use their spectacles, while only half (49%) were observed using them. Optical factors and beliefs surrounding spectacles were predictive of acceptance, while the authors suggested that day-to-day use might increase if students were less concerned over appearance as the finding showed that those not concerned over appearance were 2.04 times more likely to have spectacles on the day of inspection.¹⁶ As several reports in different environments have reported appearance as a barrier to spectacle use, this suggestion by the authors could be applicable to wider populations.

Overall, as screening programs for refractive error become increasingly common throughout the world; new strategies are needed to improve compliance if program resources are to be maximized.

Objectives

The objectives of this study were to:

1. Determine the prevalence of vision impairment and uncorrected refractive error among school going children in the selected schools in Malawi, Nigeria and Pakistan.
2. Determine the spectacle compliance three months after children with uncorrected refractive errors were given appropriate spectacles in selected schools in Malawi, Nigeria and Pakistan.
3. Identify the barriers to spectacle compliance for children in selected schools in Malawi, Nigeria and Pakistan.



Methodology

Approach

The study was divided into two phases:

Phase 1: a cross-sectional study, involved vision screenings to determine the prevalence of refractive error in school going children.

Phase 2: a longitudinal study design to determine the spectacle compliance of the children with refractive error.

Study participants

The participants of the study were children attending schools (primary, lower secondary and upper secondary) in Malawi, Nigeria and Pakistan. Schools were chosen based on their availability during data collection period.

Sample size determination

In order to estimate the prevalence of uncorrected refractive error in school going children, the sample size for Phase 1 was calculated separately for each country, based on the anticipated need of enrolling a minimum of 50 children in each country, which is a sufficient sample to reliably detect spectacle compliance with adequate power in Phase 2. In Malawi and Nigeria, we estimated that we would need to screen a minimum of 2500 children in order to identify 50 children with uncorrected refractive error (based on a conservative expected prevalence of 2%). In Pakistan, we estimated that we would need to screen a minimum of 2000 children in order to identify 100 children with uncorrected refractive error (based on a conservative expected prevalence of 5%).

Inclusion and exclusion criteria

Phase 1: Cross-sectional prevalence survey

The inclusion criteria were:

- a. Children who were enrolled and studying in primary, lower and upper secondary schools.

There were no exclusion criteria in Phase 1.

Phase 2: Longitudinal compliance survey

In the compliance study, the inclusion criteria were:

- a. Children aged 8 to 16 years, and
- b. Children who were identified as having failed the vision screening ($VA < 6/9$ in any eye) in Phase 1, and
- c. Children who had significant uncorrected refractive error ($> -0.25DS$ and $> +1.50DS$, $> -0.50DC$ in astigmatism), and
- d. Children with no other ocular morbidities.

In the compliance study, the exclusion criteria were:

- a. Children whose parents/guardians did not provide consent.



Ethics

Ethical clearances were obtained from the National Health Sciences Research Committee (NHSRC) of Malawi (NHSRC#16/1650), the Cross River State Health Research Ethics Committee (CRSHREC) of Nigeria (CRS/MH/HREC/016/Vol.V/046) and the Ethical Review Board-College of Ophthalmology & Allied Vision Sciences (ERB-COAVS) of Pakistan (COAVS/3331/16) before commencement of the study.

Target areas were identified in each country to ensure that there was an urban/rural split in the schools. The Malawi study focused on Lilongwe, which is the capital city of Malawi; The Nigeria study, in Calabar, the capital of Cross River State; and the Pakistani study Rawalpindi, a semi-urban town near to the capital city of Pakistan. Schools in the catchment areas were selected and then approached and included based on their willingness to participate and availability during data collection period. It should be noted that the main objective was to determine compliance to spectacle wear and not a prevalence study hence this sampling strategy was acceptable. The parents/guardians were provided with a Participant information sheet (Refer to Appendix 4) prior to the vision screening. Informed consent (Refer to Appendix 5) was sought from parents of the child before the study was implemented. In order to prevent coercion or undue influence we gave the eligible children, parents and teachers a briefing session so that any queries were answered.

During the informed consent process, we informed the children, parents and teachers that the study was explorative in nature, that the psychological risks were minimal, and that the interviews would be conducted by trained moderators who were able to answer their concerns in the debriefing session. We also gave the children, parents and teachers an extended opportunity to ask questions before deciding whether or not to participate. We obtained informed consent from each parent of the participating children and assent from every participating children. This was obtained in writing after the children and parents had had the opportunity to carefully consider the risks and benefits and to ask any pertinent questions.

We protected the subjects' privacy and confidentiality by preventing the disclosure of, or unauthorized access to, data that could be linked to a child's identity. The only demographic information that were recorded were age, grade, visual acuity and rural/semirural. Data were collected anonymously and the identifiers were removed and destroyed as soon as possible. If there were any identifiable data, these were encrypted. Face sheets containing identifiers (e.g., names and addresses) from survey instruments were removed.

Interviews were conducted in a classroom far away from the rest of the students and staff. In the event of a face-to-face interview, it was conducted without the presence of a teacher for reasons of confidentiality and to ensure that the child felt free to comment. We linked individual participants with their responses / data and assign each participant a study ID prior to collecting data. On a separate document / file type, each participant's name along with their unique study ID (e.g., 001) was stored separately from data documents.

The researchers who were conducting the vision screening were qualified optometrists who were knowledgeable in managing eye conditions. If the conditions could not be managed by the optometrists, the participants were referred to an eye clinic where eye care services were provided. In order to ensure the child's safety, all children were examined in the presence of the teacher in charge.

Procedures

Phase 1: Cross-sectional prevalence survey

To determine the presence of refractive error, the procedures are outlined in the flowchart, Figure 2. The child's final classification of emmetropia, refractive error type or ocular morbidity was determined by the category identified in the better eye. All data were recorded in a data collection sheet (refer to Appendix 1).

Phase 2: Longitudinal compliance survey

To understand parents' or guardians' perspective on spectacle wear and uptake of eye care services in the local area, all parents/guardians of the children who were enrolled in Phase 2 and identified to have uncorrected refractive error were contacted via telephone for a brief interview. All data from children were recorded on a children's data collection sheet, with parent responses recorded on a parent/guardian data collection sheet (Refer to Appendix 2 and Appendix 3).

Children identified with refractive error in Phase 1 were provided with a full refraction, a range of children frames to choose from and a pair of spectacles free of charge. The class teachers then monitored and documented spectacle wear using the attendance register during the subsequent three months (using data collection sheet in Appendix 6). In order not to influence the children's spectacle wear, teachers did not remind the children to wear spectacles, nor were the children informed of the monitoring process. Following the third month, the research team conducted a surprise school visit to determine spectacle compliance and conducted a survey to determine the reasons for non-compliance. Teachers were not informed of the day of the surprise visit.

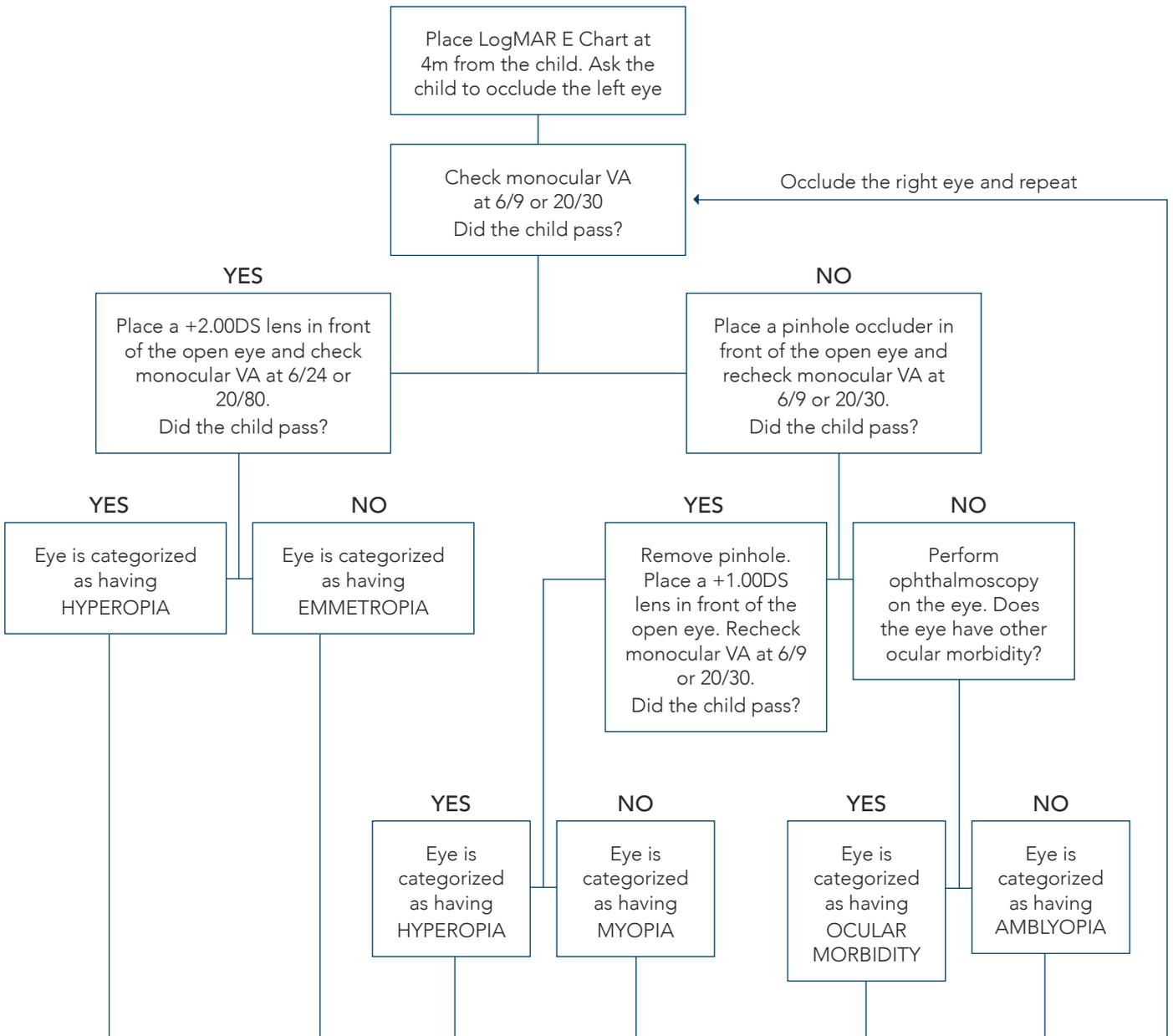
Data analysis

A data-capturing template was designed with Microsoft Access to enter the data. Double data entry was conducted by in-country personal and an investigator to minimize inaccuracies and identify data collection discrepancies. When missing data was identified by the statistician, best effort were made to retrieve the information.

Prevalence and proportions were expressed in percentages with 95% confidence interval and chi square (X^2) tests were used to determine the strength of associations between prevalence and demographic profiles using odds ratio and 95% confidence interval. Significance level was set at 5%.

Responses obtained from the parents regarding barriers to uptake of eye care services among their children were tabulated into frequencies and percentages. The responses obtained from children regarding non-spectacle compliances were tabulated into frequencies and percentages. The reasons for not wearing their spectacles at all and wearing them occasionally/part time were captured and reported separately because these two groups are likely to have distinct reasons for not wearing their spectacles. This will allow appropriately targeting spectacle compliance interventions in the future.

Figure 2: Flowchart of phase 1 procedures: Vision screening of schoolchildren to identify refractive error



Results

Malawi

Phase 1

In Malawi, children were enrolled from ten schools that included primary and lower secondary schools. Seven schools were from urban areas, while three were from rural areas. Schools were chosen based on their availability during data collection period. These schools had children enrolled in grade one to grade eight, and were typically comprised of children aged five to 18 years old. However we found that there were instances where the students were more than 20 years old (n=2, Table 1), which does occur in this setting due to the fact that some children are unable to access schools at the appropriate age for various reasons.

There were more children aged 6-11 years old (56.2%), compared to children aged 12 years and older (43.8%, Table 1).

Table 1: Malawi - Demographic profiles of children screened in Phase 1 (n = 2,993)

Demographic	Frequency, n (%)
Age group (years)	
6-11	1,682 (56.2)
≥12	1,311 (43.8)
Gender	
Male	1,294 (43.2)
Female	1,699 (56.8)
School grade	
1	NA
2	1 (0.0)
3	460 (15.4)
4	495 (16.5)
5	514 (17.2)
6	547 (18.3)
7	528 (17.6)
8	448 (15.0)
Total	2,993

In terms of gender, there were more girls (56.8%) than boys (43.2%) screened. There were no grade - one students in the sample and the participants spread across grades two to eight, with a range of 15.0% to 18.3%.

The prevalence of children with vision impairment (failing VA at 6/9) was 2.2% (95% CI 1.7%-2.7%) and the prevalence of myopia and hyperopia were similar at 1.4% (95%CI 1.0% - 1.9%) and 1.9% (95% CI 1.4%-2.4%), respectively (Table 2).

Table 2: Malawi - Vision screening results of children (n=2993)

Vision Screening	Frequency, n	Percentage (95%CI)
Unaided vision		
6/9 or better	2,927	97.8 (97.3 – 98.3)
Worse than 6/9	65	2.2 (1.7 – 2.7)
Total	2,992	100.0
Eye status		
Ocular Morbidities	7	0.2
Emmetropia	2,884	96.4 (95.7 – 97.0)
Hyperopia	58	1.9 (1.4 – 2.4)
Myopia	44	1.4 (1.0 – 1.9)
Total	2,993	100.0

Missing data: unaided vision was missing for one participant

Although a greater proportion of children in the older age group had refractive error (4.2%) in comparison to the younger age group (2.8%), it was not statistically significant (p=0.087). Similarly, there was no significant difference in prevalence of eye status between boys and girls (p=0.314). When comparing the eye diagnosis of the children (Table 3), there were more children with myopia and hyperopia in the older age group, however there were no significant statistical differences between age groups and gender (p=0.161 and p=0.439, respectively).

Table 3: Malawi - Eye status and the demographic profiles of children (n=2993)

Demographic Profiles		Ocular Morbidities n (%)	Emmetropia n (%)	Myopia n (%)	Hyperopia n (%)	Total Number	P-Value*
Age Group	6-11	3 (0.2)	1,629 (97.0)	19 (1.1)	28 (1.7)	1,679	0.161
	≥12	4 (0.3)	1,252 (95.5)	25 (1.9)	30 (2.3)	1,311	
Gender	Male	5 (0.4)	1,245 (96.3)	17 (1.3)	26 (2.0)	1,293	0.439
	Female	2 (0.1)	1,636 (96.4)	27 (1.6)	32 (1.9)	1,697	
Total		7 (0.2)	2,881 (96.4)	44 (1.5)	58 (1.9)	2,990	-

*Age and gender group comparisons based on X² test

Missing data: refractive error/ocular morbidity were missing for three participants

Phase 2

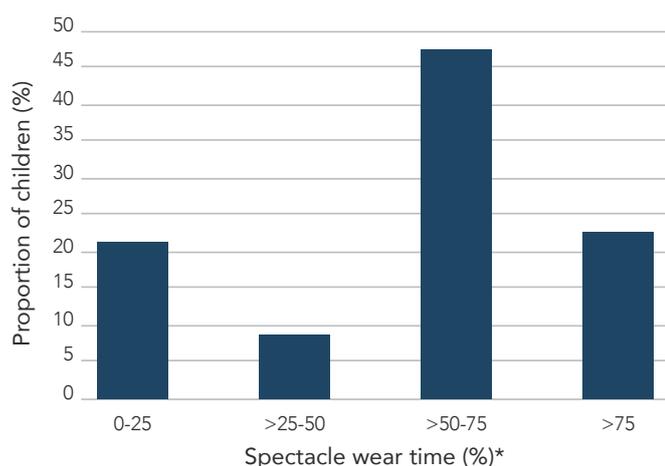
Seventy children were followed up in Phase 2 and the demographic profiles are presented in Table 4. The sample cohort shows that 55.7% were girls, 37.1% were younger children, 1.4% attended a rural school and over 75% reported that they were current spectacle wearers.

Table 4: Malawi – Demographic profile of children who were followed up in Phase 2 (n=70)

Demographic	Frequency, n (%)
Age group (years)	
8-11	26 (37.1%)
≥12	44 (62.9%)
Gender	
Male	31 (44.3%)
Female	39 (55.7%)
Location	
Urban	69 (98.6%)
Rural	1 (1.4%)
Self-reported spectacle wear	
Current wearer	53 (75.7%)
Non wearer	17 (24.3%)

The average observed spectacle compliance among the 70 children was 53.5% of the time (SD ± 29.2%). There were 70.0% (n=49) of the subjects with relatively higher compliance (47.1% of subjects having worn spectacles between 50 to 70% of the time, and 22.9% wore spectacles 75% of the time or more). The detailed breakdown is shown in Figure 3.

Figure 3: Observed spectacle compliance among children in Malawi (n=70)



* Spectacle compliance = [(No. of times observed wearing spectacles/Total no. of observations)*100]

Table 5 presents average observed compliance of spectacle wear categorized by age groups, gender and location. Higher spectacle compliance was observed in girls and children in the younger age group. However, these differences were marginal and not statistically significant.

Table 5: Malawi - Average observed spectacle compliances and demographic profiles of children (n=70)

Demographic	Average Compliance (%)	Standard Deviation, ± (%)
Age group (years)		
8-11	54.3	29.3
≥12	53.1	30.6
Gender		
Male	47.1	32.5
Female	58.6	27.1
Location		
Urban	53.7	29.9
Rural	42.4	NA*

Missing data: unaided vision was missing for one participant

Table 6 presents children's responses and opinions on spectacle wear at the surprise visits, scheduled three months after spectacles were provided. Approximately 25% of the sample (n=17) reported that they were not wearing their spectacles, with less than 10% of the children wearing the spectacles on a constant basis. When asked about spectacle wear, the majority of children (47.1%) reported that they were not wearing spectacles due to their parent's disapproval. Additional reasons were poor vision or headaches with the spectacles (both 35.3%). About 40% of the children also responded that they wore their spectacles part time, as they did not think full time wear was required (41.7%) and that their parents disapproved (39.6%).

Table 4: Malawi – Demographic profiles of children who were followed up in Phase 2 (n=70)

Questions	Frequency (%)
How long have you been wearing your spectacles? (n=70)	
Not wearing spectacles	17 (24.3)
< 3 Months	29 (41.4)
3 Months	24 (34.3)
How often do you wear your spectacles in a day? (n=70)	
Not wearing spectacles	17 (24.3)
All the time	5 (7.1)
Occasionally/part time wear	48 (68.6)
Reasons for not wearing spectacles at all* (n=17)	
Did not see well with spectacles	6 (35.3)
Spectacles lost	2 (11.8)
Friends tease when I wear them	3 (17.6)
Spectacles were uncomfortable	7 (41.2)
Do not like to wear spectacles	1 (5.9)
Spectacles caused headache	6 (35.3)
Disapproval by parents	8 (47.1)
Reasons for wearing spectacles occasionally/part time* (n=48)	
Teased by friends	13 (27.1)
Feel uncomfortable with spectacles	9 (18.8)
Do not like wearing them	4 (8.3)
Do not have to use often	20 (41.7)
Scratches on spectacles	4 (8.3)
Spectacles causes headache	8 (16.7)
Disapproval by parents	19 (39.6)
Others	14 (29.2)

Sixty-four parents or guardians of the children with refractive error participated in the survey, while six adults refused. Table 7 shows the demographic profiles of the parents and guardians that responded to the survey. The majority of participants were mothers (59.4%) and from the 30-59 year-old group (84.4%). Approximately two-thirds of the adults were not wearing spectacles. Of those who were wearing spectacles, an equal number of participants were wearing spectacles for distance or near (both n=7).

Table 7: Malawi - Demographic profiles of parents/guardians of children followed up in Phase 2, (n=64)

Demographic	Frequency, n (%)
Respondent	
Father	13 (20.3)
Mother	38 (59.4)
Other	13 (20.3)
Age (years)	
< 30	5 (7.8)
30-59	54 (84.4)
≥ 60	4 (6.3)
Unsure/missing	1 (1.6)
Gender of respondent	
Male	18 (28.1)
Female	46 (71.9)
Spectacle wear	
Yes	21 (32.8)
No	43 (67.2)
Type of glasses*	
For far vision	7 (10.9)
For near vision	7 (10.9)
Both far and near vision	4 (6.3)
I don't know	3 (4.7)

* Total number of respondents = 21

Table 9: Malawi – Parents and guardians’ reasons for their children not wearing their spectacles (n=29)

Reason for not Wearing the Spectacles	With a Child not Wearing Spectacles, n (n=29)	With a Child Wearing Spectacles Occasionally/Part-Time, n (n=32)
I disapprove my child wearing spectacles	15	1
I don't think they need to wear them all the time	0	27
My child says the spectacles are uncomfortable	5	2
My child does not see well with spectacles	3	2
My child's friends tease my child when he/she wears them	2	6
My child does not like to wear spectacles	1	3
Spectacles causes my child to have headache(s)	1	2
Fear my child will break the spectacles	0	12
Other	22	6

NOTE: Respondents were able to give a maximum of three responses for these questions.

A description of parents or guardians response and opinions on their child's spectacle wear compliance are presented in Table 8 to Table 10. Although more than half of the parents or guardians reported their children wearing spectacles, only 4.8% reported children wearing spectacles all the time. The key reasons for children not wearing spectacles included disapproval, as they were perceived to deteriorate children's vision. Some guardians also responded that they did not take the research seriously and that they were not aware that their children were provided with spectacles.

Table 8: Malawi - Responses on spectacle compliance from parents/guardians of children with spectacles (n=64)

Questions	Frequency (%)
Is your child wearing spectacles?	
Yes	35 (54.7)
No	29 (45.3)
How often does your child wear his/her spectacles?*	
Not wearing	29 (45.3)
Occasionally/part time wear	32 (50.0)
All the time	3 (4.7)

* One participant did not provide a response

Among adults of children who wore spectacles part-time, the majority of adults (79.4%) reported that they thought full time wear was not required. Teasing from peers was observed and reported by six guardians, and avoiding spectacle breakage and potential worsening of eyesight with spectacle wear were notable reasons for reduced compliance.

Table 10 shows the proportion of adults willing to pay for the next eye examination and a new pair of glasses when required. The main reasons for willingness to pay were concerns over their children’s vision, the want for vision assessments and correction to be provided to the children. Those who responded with unwillingness to pay quoted unaffordability for both eye examination and glasses as the main reason.

Table 10: Malawi - Willingness to pay for eye examinations and purchase new spectacles for children (n=64)

Willingness to Pay	Frequency, n (%)
Pay for an eye examination?	
Yes	53 (82.8)
No	11 (17.2)
Purchase a new pair of spectacles when required?	
Yes	52 (81.3)
No	12 (18.8)
Total	64 (100.0)

* One participant did not provide a response

Overall, children with refractive error and their parents and guardians showed positive attitudes towards children wearing spectacles (Table 11). There were no significant differences in children’s and adults’ attitudes towards spectacle wear except a significantly greater proportion of children perceived spectacle wear to make children look smarter ($p < 0.001$).

Table 10: Malawi - Willingness to pay for eye examinations and purchase new spectacles for children (n=64)

Opinions	Children’s Responses Frequency, n (%)	Parents’ or Guardian’s Responses Frequency, n (%)	P-Value*
Wearing glasses makes a child looks smarter			
Agree	61 (87.1)	37 (57.8)	<0.001
Disagree	9 (12.9)	27 (42.2)	
Girls should not wear spectacles			
Agree	3 (4.3)	2 (3.1)	>0.05
Disagree	67 (95.7)	62 (96.9)	
Boys should not wear spectacles			
Agree	3 (4.3)	3 (4.7)	>0.05
Disagree	67 (95.7)	61 (95.3)	
Wearing spectacles makes a child looks like a nerd/geek			
Agree	2 (2.9)	5 (7.8)	>0.05
Disagree	68 (97.1)	59 (92.2)	
Do you think it is important for a child to wear spectacles?			
Yes	67 (95.7)	63 (98.4)	>0.05
No	3 (4.3)	1 (1.6)	
Do you think parents should encourage children to wear spectacles?			
Yes	65 (92.9)	63 (98.4)	>0.05
No	5 (7.1)	1 (1.6)	

*Comparisons based on χ^2 or Fisher’s exact test



Nigeria

Phase 1

In Nigeria, children in lower and upper secondary classes from 11 schools were enrolled — nine schools were from urban areas, one school was from semi-urban areas, while one was located in a rural area. Only secondary school children were screened due to primary school teachers' strikes during data collection. There were 3.7 times more children screened who were 12 years and older (78.9%) compared to children 6-11 years old in the sample (21.1%). In terms of gender, the ratio of boys to girls was also almost the same (ratio 1:0.84). The detailed breakdown is shown in Table 12.

Table 12: Nigeria - Demographic profiles of children screened in Phase 1 (n=4,001)

Demographic	Frequency, n (%)
Age group (years)	
6-11*	845 (21.1)
≥ 12	3,155 (78.9)
Gender	
Male	2,156 (53.9)
Female	1,841 (46.1)
School grade	
Lower Secondary	2,228 (55.7)
Upper Secondary	1,773 (44.3)
Total	4,001

* Total number of respondents = 21

Table 14: Nigeria - Eye status and demographic profiles of children

Demographic Profiles		Ocular Morbidities n (%)	Emmetropia n (%)	Myopia n (%)	Hyperopia n (%)	Total Number	P-Value*
Age Group	6 - 11	0 (0.0)	805 (95.3)	22 (2.6)	18 (2.1)	845	0.353
	≥ 12	0 (0.0)	2,965 (94.0)	99 (3.1)	91 (2.9)	3,156	
Gender	Male	0 (0.0)	2,031 (94.1)	65 (3.0)	62 (2.9)	2,158	0.822
	Female	0 (0.0)	1,740 (94.4)	56 (3.0)	47 (2.6)	1,843	
Total		0.0 (0.0)	3,771 (94.3)	121 (3.0)	109 (2.7)	4,001	-

The prevalence of children with vision impairment (failing VA at 6/9) was 11.0% (95% CI 10.0% - 12.0%) and the prevalence of refractive error was 5.7% (95% CI 5.0% - 6.5%) (Table 13). The prevalence of myopia was 3.0% (95%CI 2.5% - 3.6%) and is marginally more than the prevalence of hyperopia 2.7% (95%CI 2.2% - 3.2%).

Table 13: Nigeria - Vision screening results of children (n=4,001)

Vision Screening	Frequency, n	Percentage (95% Confidence Interval)
Unaided Vision		
6/9 or better	3,559	89.0 (88.0 – 90.0)
Worse than 6/9	440	11.0 (10.0 – 12.0)
Total	3,999	100.0
Eye Status		
Ocular Morbidities	0	-
Emmetropia	3,771	94.3 (93.5 – 95.0)
Hyperopia	109	2.7 (2.2 – 3.2)
Myopia	121	3.0 (2.5 – 3.6)
Total	4,001	100.0

Missing data: unaided vision were missing for two participants

When comparing the prevalence of eye status of the children, it was found that there was no statistical significance between age group and between genders (p=0.353 and p=0.822, respectively). The detail breakdown is shown in Table 14.

Phase 2

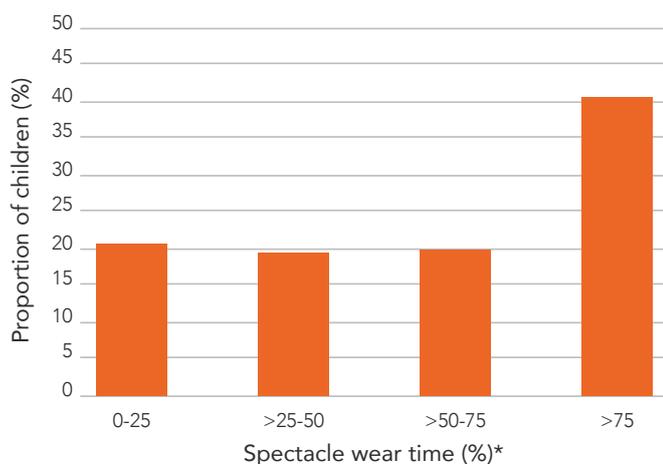
In Phase 2, a total of 219 children with refractive error were followed up and a detailed breakdown of the demographic profile is presented in Table 15. Of the children followed up, a greater proportion of the participants were older, male, current spectacle wearers and from urban areas.

Table 15: Nigeria - Demographic profiles of children followed up in Phase 2 (n=219)

Demographic	Frequency, n (%)
Age group (years)	
8-11	38 (17.4)
≥12	181 (82.6)
Gender	
Male	120 (54.8)
Female	99 (45.2)
Location	
Urban	197 (90.0)
Rural	2 (0.9)
Semi Urban	20 (9.1)
Self-reported spectacle wear	
Current wearer	183 (83.6)
Non wearer	36 (16.4)

The average observed spectacle compliance among the children followed up was 59.2% (SD ± 32.4%) of the observed time. As shown in Figure 4, 60.2% of the participants had compliance higher than 50% with spectacle wear, 19.6% of children between 50% and 75% of the time while 40.6% wore spectacles more than 75% of the observed time.

Figure 4: Observed spectacle compliances among school-children in Nigeria (n=219)



* Spectacle compliance = [(No. of times observed wearing spectacles/Total no. of observations)*100]

Although not statistically significant, compliance with spectacle wear was higher among girls and children from rural areas (Table 16).

Table 16: Nigeria - Average observed spectacle compliance and demographic profiles of children (n=219)

Demographic	Average Compliance (%)	Standard Deviation (%)
Age group (years)		
8-11	54.3	29.3
≥12	53.1	30.6
Gender		
Male	47.1	32.5
Female	58.6	27.1
Location		
Urban	53.7	29.9
Rural	42.4	NA*

At the three month follow up, 36 children reported that they were not wearing their spectacles, while 88 children reported that they were wearing spectacles full time. Of the children not wearing spectacles, the main reported reasons were due to lost spectacles (33.3%) or broken spectacles (22.2%). Of the 95 children only wearing spectacles part-time, the majority perceived that spectacle wear was not required all the time (43.2%), felt uncomfortable wearing spectacles (17.9%) or were teased by friends (13.7%). A detailed outline of children's responses to spectacle wear compliance is presented in Table 17.

Table 17: Nigeria - Children's responses regarding spectacle compliance after 3 months (n=219)

Questions	Frequency (%)
How long have you been wearing your spectacles? (n=219)	
Not wearing spectacles	36 (16.4)
3 months	183 (84.6)
How often do you wear your spectacles in a day? (n=219)	
Not wearing specs	36 (16.4)
All the time	88 (40.2)
Occasionally/part time wear	95 (43.3)
Reasons for not wearing spectacles at all* (n=36)	
Did not see well with spectacles	4 (11.1)
Spectacles broken	8 (22.2)
Spectacles lost	12 (33.3)
Friends tease when I wear them	0 (0.0)
Spectacles were uncomfortable	6 (16.7)
Do not like to wear spectacles	2 (5.6)
Spectacles caused headache	1 (2.8)
Parents disapprove spectacle usage	8 (22.2)
Other	1 (2.8)
Reasons for wearing spectacles occasionally/part time* (n=95)	
Teased by friends	13 (13.7)
Feel uncomfortable with spectacles	17 (17.9)
Do not like wearing them	4 (4.2)
Do not have to use often	41 (43.2)
Scratches on spectacles	0 (0.0)
Spectacles causes headache	2 (2.1)
Disapproval by parents	9 (9.5)
Other	0 (0.0)

Results

Nigeria

All the parents/guardians of the children surveyed in Phase 2 participated in the telephone survey. A greater proportion of respondents were male, middle-aged and spectacle wearers. Of those who wore glasses, the majority of adults wore spectacle only for near vision. The detailed breakdown is shown in Table 18.

Table 18: Nigeria - Demographic profiles of parents/guardians of children followed up in Phase 2 (n=219)

Demographics	Frequency, n (%)
Respondent	
Father	61 (27.9)
Mother	58 (26.5)
Other	100 (45.7)
Age (years)	
< 30	25 (11.4)
30-59	177 (80.8)
≥ 60	17 (7.8)
Gender of the respondent	
Male	122 (55.7)
Female	97 (44.3)
Spectacle wear	
Yes	129 (58.9)
No	90 (41.1)
Type of glasses*	
For far vision	7 (5.4)
For near vision	104 (80.6)
Both far and near vision	17 (13.2)
I don't know	1 (0.8)

* Total number of respondents = 129

Table 20: Nigeria – Parents' or guardians' reasons for their children not wearing their spectacles

Reason for not Wearing the Spectacles	With a Child not Wearing Spectacles, n (n=39)	With a Child Wearing Spectacles Occasionally/Part-Time, n (n=143)
I disapprove my child wearing spectacles	5	2
I don't think they need to wear them all the time	0	76
My child says the spectacles are uncomfortable	4	13
My child does not see well with spectacles	3	0
My child's friends tease my child when he/she wears them	2	4
My child does not like to wear spectacles	9	18
Spectacles causes my child to have headache(s)	1	1
My child's spectacles are broken/lost	16	1
Fear my child will break the spectacles	0	4
Other	3	39

NOTE: Respondents were able to give a maximum of three responses for these questions.

Table 19 shows parents' and guardians' responses to their child's spectacle wear compliance. While the majority said their child was wearing spectacles, less than 17% reported full time wear.

Table 19: Nigeria - Responses of parents/guardians regarding children's spectacle wear compliance (n=219)

Question	Frequency, n (%)
Is your child wearing spectacles?	
Yes	180 (82.2)
No	39 (17.8)
How often does your child wear his/her spectacles?	
Not wearing	39 (17.8)
Occasionally/part time wear	143 (65.3)
All the time	37 (16.9)

The most commonly reported reasons from parents or guardians on why their children were not wearing spectacles included broken/lost spectacles or their children did not like to wear them. Other reasons quoted included uncomfortable wear, parents disapproved or child being teased by friends for wearing spectacles (Table 20). For parents or guardians who had children only wearing spectacles part-time, the main reasons for doing so were because spectacles were perceived to only be needed some of the time, while other reported children disliking or feeling uncomfortable with spectacles (Table 20).

Results
Nigeria

The majority of parents and guardians responded that they were willing to pay for the next eye examination and willing to buy their children a new pair of glasses if required. (Table 21).

Table 21: Nigeria - Willingness to pay for eye examinations and purchase new spectacles for children (n=128)

Willingness to Pay	Frequency, n (%)
Pay for an eye examination?	
Yes	127 (99.2)
No	1 (0.8)
Purchase a new pair of spectacles when required?	
Yes	127 (99.2)
No	1 (0.8)
Total	128 (100)

NOTE: Willingness to pay data was not obtained from 91 parents/guardians

Children with refractive error, parents and guardians all showed positive attitudes towards spectacle wear with the exception that a significantly greater proportion of children felt wearing spectacles made children look smarter and like a nerd or geek compared to adults (both $p < 0.001$). Despite this finding, almost all children responded that wearing spectacles was important and parents should encourage wear. More than 83% of all of the guardians had favorable opinions towards children wearing spectacles. The responses are shown in Table 22.

Table 22: Nigeria - Children's (n=219) and parents' or guardians' (n=219) attitudes towards spectacle wear

Opinions	Children's Responses Frequency, n (%)	Parents' or Guardian's Responses Frequency, n (%)	P-Value*
Wearing glasses makes a child looks smarter			
Agree	175 (79.9)	102 (46.6)	<0.001
Disagree	44 (20.1)	117 (53.4)	
Girls should not wear spectacles			
Agree	13 (5.9)	14 (6.4)	>0.05
Disagree	206 (94.1)	205 (93.6)	
Boys should not wear spectacles			
Agree	9 (4.1)	13 (5.9)	>0.05
Disagree	207 (95.9)	206 (94.1)	
Wearing spectacles makes a child looks like a nerd/geek			
Agree	100 (45.7)	37 (16.9)	<0.001
Disagree	119 (54.3)	182 (83.1)	
Do you think it is important for a child to wear spectacles?			
Yes	217 (99.1)	217 (99.1)	>0.05
No	2 (0.9)	2 (0.9)	
Do you think parents should encourage children to wear spectacles?			
Yes	216 (98.6)	215 (98.2)	>0.05
No	3 (1.4)	4 (1.8)	



Pakistan

Phase 1

In Pakistan, children were enrolled from 12 primary, lower or upper secondary schools — eight schools were from urban areas, while four were located in rural areas. Primary schools in Pakistan also include 'pre-primary' classes. These were also included in the screening in Pakistan. The highest number of children enumerated were those in the 6-11 years old age group followed by the 12 years and older, and 4-5 years old. In terms of gender, there were slightly more boys than girls having had vision screenings. The participant numbers ranged from 3.1% (grade 11) to 16.2% (pre-primary). The demographic profiles are described in Table 23.

Table 23: Pakistan - Demographic profiles of children screened in Phase 1 (n=4,157)

Demographic	Frequency, n (%)
Age group (years)	
≤5	368 (8.9)
6-11	1,921 (46.2)
≥12	1,868 (44.9)
Gender	
Male	2,166 (52.1)
Female	1,991 (47.9)
School grade	
Pre-Primary	674 (16.2)
1	479 (11.5)
2	500 (12.0)
3	362 (8.7)
4	465 (11.2)
5	358 (8.6)
6	303 (7.3)
7	253 (6.1)
8	217 (5.2)
9	247 (5.9)
10	172 (4.1)
11	127 (3.1)
Total	4,157 (100.0)

Table 25: Pakistan - Eye status and demographic profiles of children (n=4,146)

Demographic Profiles		Ocular Morbidities n (%)	Emmetropia n (%)	Myopia n (%)	Hyperopia n (%)	Total Number	P-Value*
Age Group	≤ 5	0 (0.0)	367 (99.7)	1 (0.3)	0 (0.0)	368	<0.001
	6 - 11	2 (0.1)	1,862 (97.1)	41 (2.1)	13 (0.7)	1,918	
	≥ 12	6 (0.3)	1,688 (90.8)	154 (8.3)	12 (0.6)	1,860	
Gender	Male	5 (0.2)	2,081 (96.4)	60 (2.8)	12 (0.6)	2,158	<0.001
	Female	3 (0.2)	1,836 (92.4)	136 (6.8)	13 (0.7)	1,988	
Total		8 (0.2)	3,917 (94.5)	196 (4.7)	25 (0.6)	4,146	-

*Age and gender group comparisons based on χ^2 test
Missing data: Eye status results were missing for 11 participants

The prevalence of children with vision impairment (failing VA at 6/9) was 5.4% (95%CI 4.7%- 6.0%) (Table 24) and the prevalence of refractive error was 5.3% (95%CI 4.0% - 6.0%).

Table 24: Pakistan - Vision screening results of children (n=4,157)

Vision Screening	Frequency, n	Percentage (95% Confidence Interval)
Unaided Vision		
6/9 or better	3,559	89.0 (88.0 – 90.0)
Worse than 6/9	440	11.0 (10.0 – 12.0)
Total	3,999	100.0
Eye Status		
Ocular Morbidities	0	-
Emmetropia	3,771	94.3 (93.5 – 95.0)
Hyperopia	109	2.7 (2.2 – 3.2)
Myopia	121	3.0 (2.5 – 3.6)
Total	4,001	100.0

Missing data: unaided vision was missing for two participants

The prevalence of myopia is 4.7% (95%CI 4.1% - 5.4%) and is 7.8 times higher than hyperopia 0.6% (95%CI 0.4% - 0.8%). When comparing the prevalence of eye status, a statistically significant difference between children in different age groups was observed ($p<0.001$), with more children from the older age group having myopia (8.3%) compared to the younger age groups (2.1% and 0.3%). Furthermore, girls were 2.3 times more likely to have myopia compared to boys ($p<0.001$). The detail breakdown is shown in Table 25

Phase 2

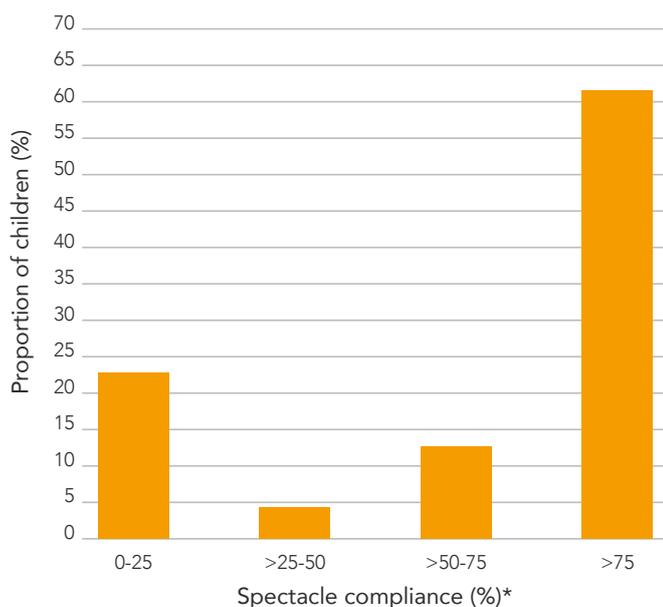
In Phase 2, 98 children with refractive error were followed up. A greater proportion of participants were in the older age group (n=71, 72.5%), girls (n=55, 56.1%) and children from rural areas (n=53, 54.1%). Seventy-four children (75.5%) were current spectacle wearers. The detailed breakdown of their demographic profile is shown in Table 26.

Table 26: Pakistan - Demographic profile of children who were followed up in Phase 2 (n=98)

Demographic	Frequency, n (%)
Age group (years)	
8-11	27 (27.5)
≥12	71 (72.5)
Gender	
Male	43 (43.9)
Female	55 (56.1)
Location	
Urban	45 (45.9)
Rural	53 (54.1)
Self-reported spectacle wear	
Current wearer	74 (75.5)
Non wearer	24 (24.5)

The average observed spectacle compliance among the 98 children followed up was 68.9% (SD ± 37.5%) of the observed time. Figure 5 shows that 61.2% (n=60) of participants were compliant with spectacle wear for at least 75% of the observed times.

Figure 5: Observed spectacle compliance among schoolchildren in Pakistan (n=98)



* Spectacle compliance = [(No. of times observed wearing spectacles/Total no. of observations)*100]

When looking at observed spectacle compliance among age groups, gender and location, marginally greater compliance was observed amongst boys,

older children and children from rural areas. (Table 27) However, these differences were not statistically significant.

Table 27: Pakistan – Average observed spectacle compliance and demographic profiles of children (n=98)

Demographic	Average Compliance (%)	Standard Deviation, ± (%)
Age group (years)		
8-11	67.0	39.6
≥12	69.6	36.9
Gender		
Male	69.2	40.2
Female	68.6	35.6
Location		
Urban	64.8	40.0
Rural	72.3	35.2

At the three-month follow up, approximately one-quarter of children reported that they were not wearing spectacles, whereas approximately half of the children reported that they were wearing spectacles all the time. Of the children no longer wearing spectacles, the main reported reason was that the spectacles were broken or they disliked wearing them. The most commonly reported reasons for only wearing spectacles part time were being teased by friends, or that they did not like wearing them. The responses are shown in Table 28.

Table 28: Pakistan - Children's responses regarding spectacle compliance (n=98)

Questions	Frequency (%)
How long have you been wearing your spectacles? (n=98)	
Not wearing Specs	24 (24.5)
3 Months	74 (75.5)
How often do you wear your spectacles in a day? (n=98)	
Not wearing specs	24 (24.5)
All the time	53 (54.1)
Occasionally/part time wear	21 (21.4)
Reasons for not wearing spectacles at all* (n=24)	
Did not see well with spectacles	2 (8.3)
Spectacles broken	9 (37.5)
Spectacles lost	2 (8.3)
Friends tease when I wear them	2 (8.3)
Spectacles were uncomfortable	2 (8.3)
Do not like to wear spectacles	5 (20.8)
Spectacles caused headache	2 (8.3)
Other	2 (8.3)
Reasons for wearing spectacles occasionally/part time* (n=21)	
Teased by friends	5 (23.8)
Feel uncomfortable with spectacles	3 (14.3)
Do not like wearing them	5 (23.8)
Do not have to use often	4 (19.0)
Scratches on spectacles	0 (0.0)
Spectacles causes headache	0 (0.0)
Disapproval by parents	1 (4.8)
Other	3 (14.3)

* Respondents were able to give a maximum of three responses for this question.

A total of 98 parents or guardians of children who were prescribed with spectacles participated in the survey. The demographic profile of respondents are described in Table 29. About 25% of the adults were spectacle wearers, and of those, the majority only wore them for near vision.

Table 29: Pakistan – Demographic profiles of parents/guardians of children followed up in Phase 2 (n=98)

Demographics	Frequency, n (%)
Respondent	
Father	28 (28.6)
Mother	42 (42.9)
Other	28 (28.6)
Age (years)	
< 30	9 (9.2)
30- 59	88 (89.8)
≥ 60	1 (1.0)
Gender of respondent	
Male	49 (50.0)
Female	49 (50.0)
Spectacle wear	
Yes	25 (25.5)
No	73 (74.5)
Type of glasses*	
For far vision	2 (8.0)
For near vision	18 (72.0)
Both far and near vision	5 (20.0)

*Total number of respondents = 25

When asked about their children's spectacle wear, 74 guardians responded that their children were wearing their spectacles, while only 53 guardians responded that their children wear the glasses all the time. The breakdown is shown in Table 30.

Table 30: Pakistan - Responses on spectacle compliance from parents/guardians of children prescribed with spectacles (n=98)

Question	Frequency, n (%)
Is your child wearing spectacles?	
Yes	74 (75.5)
No	24 (24.5)
How often does your child wear his/her spectacles?	
Not wearing	24 (24.5)
Occasionally/part time wear	21 (21.4)
All the time	53 (54.1)

The main response to why children were not wearing their spectacles were because of broken or lost spectacles. Other reasons reported include that the children were not comfortable wearing the spectacles and the children did not like wearing the spectacles. The guardians' responses are shown in Table 31.

When asked why their children were wearing spectacles occasionally or part-time, the majority of responses (n=10) were that their children did not like wearing the spectacles. Other reasons quoted included that the children did not feel comfortable with glasses and being teased by their friends when wearing their spectacles (Table 31).

Table 31: Pakistan – Parents or guardians' reasons for their children not wearing their spectacles

Reason for not Wearing the Spectacles	With a Child not Wearing Spectacles, n (n=39)	With a Child Wearing Spectacles Occasionally/Part-Time, n (n=143)
I disapprove my child wearing spectacles	4	0
I don't think they need to wear them all the time	0	0
My child says the spectacles are uncomfortable	6	6
My child does not see well with spectacles	0	0
My child's friends tease my child when he/she wears them	0	4
My child does not like to wear spectacles	7	10
Spectacles causes my child to have headache(s)	2	0
My child's spectacles are broken/lost	10	0
Fear my child will break the spectacles	0	1
Other	0	2

NOTE: Respondents were able to give a maximum of three responses for these questions.

The majority of parents or guardians responded that they were willing to pay for the next eye examination and 67.3% of the parents were willing to buy their children a new pair of glasses when required. (Table 32).

Table 32: Pakistan - Willingness to pay for eye examinations and purchase new spectacles for children (n=98)

Willingness to Pay	Frequency, n (%)
Pay for an eye examination?	
Yes	70 (71.4)
No	28 (28.6)
Purchase a new pair of spectacles when required?	
Yes	66 (67.3)
No	32 (32.7)

The main reasons for their willingness were that they are concerned about their children’s vision and that it is for the betterment of the child’s health. They want their children to have good vision. Those who showed their unwillingness quoted unaffordability for both eye examination and glasses as their main reason.

Despite reports of dislike in spectacle wear, overall the children’s attitude to wearing spectacles was positive. More than 72% of the children showed favorable attitude towards spectacle wear. It was also shown that more than 96% of the children think wearing spectacles is important and parents should encourage their children to wear their spectacles. The guardians also

showed positive attitude towards children’s spectacle wear. More than 67% all of the guardians had favorable opinions towards children wearing spectacles. The responses are presented in Table 33.

Table 33: Pakistan - Children’s (n=98) and parents’ or guardian’s (n=98) attitudes towards spectacle wear

Opinions	Children’s Responses Frequency, n (%)	Parents’ or Guardian’s Responses Frequency, n (%)	P-Value*
Wearing glasses makes a child looks smarter			
Agree	71 (72.4)	66 (67.3)	>0.05
Disagree	27 (27.6)	32 (32.7)	
Girls should not wear spectacles			
Agree	23 (23.5)	16 (16.3)	>0.05
Disagree	75 (76.5)	82 (83.7)	
Boys should not wear spectacles			
Agree	23 (23.5)	15 (15.3)	>0.05
Disagree	75 (76.5)	83 (84.7)	
Wearing spectacles makes a child looks like a nerd/geek			
Agree	71 (72.4)	76 (77.6)	>0.05
Disagree	27 (27.6)	22 (22.4)	
Do you think it is important for a child to wear spectacles?			
Yes	97 (99.0)	95 (96.9)	>0.05
No	1 (1.0)	3 (3.1)	
Do you think parents should encourage children to wear spectacles?			
Yes	96 (98.0)	96 (98.0)	>0.05
No	2 (2.0)	2 (2.0)	

*Comparisons based on X² or Fisher’s exact test



Discussion

The number of children who failed vision at 6/9 was highest in Nigeria (11.0%), followed by Pakistan (5.4%) and Malawi (2%).

In this study, 7,551 children from pre-primary, primary, lower and upper secondary schools were screened. Of these, 723 failed the vision screening at 6/9 and were provided with spectacles. The number of children who failed vision at 6/9 was highest in Nigeria (11.0%), followed by Pakistan (5.4%) and Malawi (2%). In phase two, 387 children with refractive errors were provided with spectacles, and spectacle compliance was observed at three months. In Malawi, students were observed to be wearing their spectacles half the time (53.5%), whereas observed spectacle compliance in Nigeria and Pakistan was 59.2% and 68.9% respectively.

Refractive errors in school going children in Malawi, Nigeria and Pakistan

In urban schools in Malawi, we found the prevalence of refractive error in children was 3.4% (95%CI 2.8%-4.1%). When compared with the other East African countries, the prevalence we found was lower than the previously published reports from rural Kenya (5.2%),²⁵ Kampala, Uganda (11.6%)²⁶ and Gondar, Ethiopia (9.4%),²⁷ However, the prevalence of refractive error in our study population in Malawi, was higher than the reported prevalence in rural Tanzania (1.0%).²⁸

In Pakistan, the prevalence of children with significant refractive error was 5.3% (95% CI 4.0% - 6.0%). This prevalence was lower than the prevalence reported in the Kathmandu study (8.1%)²⁹ and North India Study (22%)³⁰ but almost the same as the Delhi study (5.4%)³¹ and the India study (5.5%).³²

In Nigeria, the prevalence of children with significant refractive error was 5.7% (95% CI 5.0% - 6.5%). Previous studies of refractive error in children in Nigeria found prevalence of refractive error ranging from 0.87% to 8.0%.^{19,33-39} During the study period of this study, there was a strike by the primary school teachers, which resulted in the primary schools being closed during the second phase of the study. As a result, our Nigerian sample was skewed heavily towards older children, with four times as many older children than younger children participating in phase 2, which is likely to explain the a relatively high prevalence of significant refractive error found here.

Comparisons between the results presented here and those of previous studies to be made very cautiously due to the following reasons. Firstly, the previously reported studies had different sample sizes and study populations. For example, the study

in Kampala included only children aged 6 to 9 years old, with a sample size of 623 while the Kathmandu study included 4500 children from grade 5 to 9. As the prevalence of myopia increases with age due to the rapid elongation of the axial length of the eye,⁴⁰ these differences in prevalence may be a reflection of the differences in sample size and study populations.

Secondly, the settings of the previously published studies and our study varied, especially in terms of socioeconomic status and its enumeration. In the Nepal study, the enumeration of children was at household level while our study was at school level. Similarly, our study in Malawi was conducted at the capital of Malawi (Lilongwe) while the studies in Kenya and Ethiopia were conducted in rural settings. Even though the methodology was similar, the difference in enumeration and socioeconomic background of the study populations between our study and the published studies may have caused the difference in prevalence as the prevalence of uncorrected refractive error are usually higher in rural area than in urban areas due to personal, economic and social barriers in rural areas.⁴¹⁻⁴³

Finally, the year of which previous studies were conducted differed greatly. For instance, the study in Nepal, India, Uganda and Tanzania was conducted more than 10 years ago. With the efforts invested in overcoming eye health problems for the past decades, the prevalence may have decreased. For example, a recent 2016 internal monitoring exercise showed prevalence of refractive error of 2.1% and 6.1% in Tanzania and Uganda, respectively.

Screening thresholds

We employed a VA 6/9 cut off instead of the WHO screening cut off for children of 6/12 because the onset and progression of myopia is greatest during school age, and the critical time to manage myopia progression is in children up to the age of 12 years.^{44,45} By reducing the threshold for vision screening in children from 6/12 to 6/9, early myopia can be detected and treated to reduce the risk of progression due to under correction. Myopia control strategies can then be used to reduce progression to high myopia. A 50% reduction in the rate of progression of myopia and axial length will result in an 89% reduction in the number of people with myopia of -5.00 D or higher.⁴⁶ As high myopia and associated pathology affects the working age group, early detection and management

of myopia to prevent progression to high myopia has long-term implications on productivity and cost to the health system.

As the higher threshold VA of 6/9 requires better vision, a greater number of children will fail the screening, resulting in a higher overall prevalence of vision impairment. However, the recent evidence on the global prevalence of myopia and anticipate future trends¹³ indicates that it is increasingly important to use a 6/9 cut-off, as otherwise there is likely to be a significant number of low myopes (-0.50 D to -1.00 D) who are likely to remain uncorrected. The quantity of children uncorrected would be a function of the country's prevalence of myopia, however this group will be at risk of potentially a faster rate of myopic progression as a consequence of under-correction.⁴⁷

Refractive error profiles in Malawi, Nigeria and Pakistan

In Pakistan, there were eight times more children with myopia compared to hyperopia. However, in contrast, both Malawi and Nigeria have observed similar ratios in prevalence of myopia and hyperopia. These findings differed from previous regional findings where more children with hyperopia were observed compared to myopia.⁴⁸ This may be due to the difference in our school-based sampling strategy, rather than a population-based survey. Furthermore, it could also be due to the increase in demand of near vision in schools that predisposed children to developing myopia.⁴⁰ These potential changes suggest a need for improving awareness of myopia in the community including schoolchildren, their families and teachers.

There were significantly more children with refractive error from the older age group compared to the younger age group. We found that the prevalence of refractive error in our sample increased with age, particularly for myopia. A similar finding was also observed by Padhye et al. in a study of schoolchildren in urban and rural India.³² This suggests that early intervention and prevention would be most beneficial in younger age groups of under twelve years of age.

Second, there were significantly higher number of girls who had refractive error and myopia compared to boys in Pakistan. Similar results were also found by Pokharel et al. and Sapkota et al. in Nepal.^{49,50} This suggests girls are at higher risk of developing myopia, which should be detected as early as possible.

Spectacle compliance and barriers to compliance in Malawi, Nigeria and Pakistan

In Phase 2, we observed that spectacle compliance in Malawi, Nigeria and Pakistan, is reasonably high (69%, 59% and 54%). The spectacle compliance among schoolchildren in Pakistan in this study was higher than what has been reported previously in Pakistan (41%),¹⁸ but lower than those previously reported in Oman, where Khandekar et al. found a spectacle compliance of 71.6% in their sample.⁵¹ However, Gogate et al. found a lower spectacle compliance among schoolchildren in Pune, India (29.5%)²³ while Holguin et al. observed a 13.4% spectacle compliance among schoolchildren in Mexico.¹⁴

The reasons for the high spectacle compliance in the three countries might be related to a short period of follow up (three months). We hypothesized that spectacle compliance among our sample may be lower if we extend the follow up period and if there is no awareness strategy in place to sustain the wearing compliance of the children. In addition, a higher literacy in the community of the study sites: where Lilongwe is the capital city of Malawi; Calabar is the capital of Cross River State; and Rawalpindi, a semi-urban town near to the capital city of Pakistan. Where spectacle wearing is relatively common compared to the rural areas, may have also caused a high spectacle compliance among our subjects. Furthermore, a range of appealing frames available for the children to choose from may have also contributed to the high spectacle compliance rate.

However, we need to highlight that these studies have very different definition in terms of spectacle compliance. While Holguin et al. and Khandekar et al. used "wearing spectacle at the time of examination/ follow up" as spectacle compliance, Gogate et al. used an interview questionnaire to capture the information of spectacle compliance. Recognizing the limitations of these definitions, we employed teachers to observe the children's spectacle wear twice daily to assess spectacle compliance. By observing children's spectacle wear twice daily by teachers, we can improve the validity of the study results by reducing respondent bias from the children and parents. Often, children are afraid that they will be punished if they are not wearing them, thus giving a positive answer. Additionally, we can verify the child's self-reported responses regarding spectacle wear.

Discussions

Spectacle compliance and barriers to compliance in Malawi, Nigeria and Pakistan

In Malawi, the main reason for non-compliance was disapproval from parents. As mentioned previously, many parents believed that the children's vision would get worse if they wear their glasses. We expected that with our urban study population, parents would be more sensitized about spectacle wear among children. Interestingly, while there are regular health awareness campaigns, they are focused in the rural areas. We recommend that awareness campaign should also be expanded to the urban areas.

In Pakistan, the main reasons for non-compliance were that their glasses were broken and they were feeling uncomfortable with the spectacles. We observed that the breakage was due to their children's participation in sports activities. Also, bearing in mind that almost all of our subjects in all three countries are first time spectacle wearers, this first-time experience may have caused unfamiliarity in taking care of their spectacles and thus causing the breakage. While first time usage of spectacle also occurred in Malawi and Nigeria, there was more disapproval from parents in those settings, while spectacle wear in Pakistan was higher both in and outside of the classroom, which provides more opportunity for breakages to occur. Furthermore, this first-time experience may also have contributed to the discomfort felt by the children as spectacle wearing can take some time to become accustomed to. However, there could also be respondent bias in this process, as children may have disliked spectacle wearing and used discomfort as a reason for not wearing them.

In Pakistan, we observed that children stopped wearing their spectacles because friends teased them. They were given derogatory nicknames such as "four-eyes" because they came across as "clever" and can be seen as "trying to be smart". This is reflected in instances where children wearing spectacles were seen as bookworms and not included in sports activities and even given "nerdy" roles in dramas.

In Nigeria, even though the optometrists explained to the children that spectacles have to be worn constantly, we observed that children were wearing their glasses less than required because teachers perceived that spectacles should only be worn while reading, just like the adults do. Hence, the teachers advised them to only wear them in the classroom. Furthermore, parents also felt embarrassed about their children wearing spectacles because this is not their local tradition, and thus discouraged their children from wearing their spectacles all the time.

Affordability of spectacles in Malawi, Nigeria and Pakistan

Both guardians in our Malawi and Pakistan studies quoted unaffordability as the main reason for unwillingness to have their children's eyes examined and a new pair of glasses purchased when required. In a context of limited resources prioritization of health care needs is relevant in any perception around spectacle affordability, as good vision may not be valued highly, when compared to acute conditions like malaria, trauma, or diarrhea which can be life threatening

In Malawi, eye examinations are provided free in public hospitals in Malawi, however a pair of children glasses costs USD\$5 - \$13, which is approximately three to four times the annual out-of-pocket health expenditure in Malawi.⁵² Among those with no extra resources or the very poor, it will still be an affordability issue. In Nigeria, the vast majority of parents reported that they were willing to purchase spectacles for children. In Pakistan, an eye examination and a pair of children custom-made glasses costs USD\$5 to \$20. Although this cost is relatively low, it still equates to the average annual out-of-pocket health expenditure in Pakistan.⁵²

Limitations

This study is limited by the fact that the follow-up period of spectacle wear compliance was only three months. As a pair of spectacles is expected to last a child one to two years, a longer follow-up duration might show different trends, and be more representative of spectacle compliance associated with school screening programs. However, since this was an explorative study, additional follow-up can be conducted to evaluate spectacle compliance over time. It is also important to note that the spectacle compliance rates presented here may not be representative of spectacle compliance rates broadly, in Malawi, Nigeria and Pakistan.

In Nigeria, our study sample was skewed towards older children, with four times more older children compared to the younger ones, and a higher prevalence of significant refractive error was found – this result should be interpreted carefully as it will not be representative of younger students.

We also observed that teachers were not motivated in the data collection process. The data collection process required the teachers to monitor and record the children's spectacle wear twice daily. However, the teachers were reluctant to participate in the exercise because they perceived the monitoring tasks not part of their job descriptions. This delayed starting the data collection process in Nigeria.

Recommendations

While there are specific lessons that can be drawn from the compliance observation and barriers questionnaires, it is critical that service delivery is addressed as well. It is our contention that greater the availability and higher the quality of services, the easier it will be for health promotion efforts to be successful. Although this study did not evaluate the service delivery aspects, some comments are made regarding this aspect in the recommendations that emerged during the interaction with various stakeholders including children, parents and service providers.

Recommendations common to all the three countries:

1. The school health should be an integrated part of a comprehensive education package and include health promotion, prevention, treatment and referral. It should also include strategies to support children with disability.
2. School health should be a part of broader education policy and offered by a designated department in the Ministry of Education, which is responsible for the role out of various components of school health in collaboration with other line ministries including health water and sanitation, food and rural development.
3. Awareness should be raised on what spectacles are and their functions and to debunk myths among the community, teachers, parents and peers in all countries. Positive role models through different channels such as the media could provide possible solutions. The demystifying of spectacles can also discourage bullying in school.
4. Advocacy with the Ministry of Education to integrate eye health into the school health program. It is crucial that eye health is recognized by the government and responsibility taken in delivering eye care to children.
5. Advocacy to the education department to include eye health screening in the health checks before school enrolment can result in children with vision problems being identified and treated timeously.
6. Eye health should be included into education and health sector policies and relevant line departments for coordination and management created.
7. There should be timely detection of refractive errors and free provision of spectacles for children who cannot afford them.
8. The spectacles should conform to the global safety standards to withstand wear and tear and handling in outdoor activities like sports.

Malawi

1. Health education should focus on making the teachers, parents and the community, aware of the negative impact and implication of a child having uncorrected refractive error or delayed correction. This can be done through school health programs by involving children, teachers and parents.
2. To increase the willingness to pay for a pair of spectacles, we recommend different pricing strategies such as instalment plans or cross-subsidization plans. However, there is a crucial need to sensitize the community with the right information on the free eye examination provided in the public health facilities and the affordable spectacles available. This will allow subsidies and other schemes to be focused on the poorest of the poor.
3. Teachers should be provided with training in basic vision assessment and classroom management of children with refractive errors to assist in early detection of progressive myopia.
4. There is a need to develop refraction clinics and optical dispensing facilities at the district hospital level and not only at the secondary and tertiary hospitals to make refractive services more accessible.
5. Regular vision screenings and eye examinations should be provided to schoolchildren. As this is one of the first studies to investigate refractive error prevalence in children in Malawi and with refractive error predicted to increase over the next decade, early intervention is key to preventing vision impairment and blindness.

Nigeria

1. Similar to Malawi, health education should focus on improving awareness with teachers, parents and the community on the negative impact and implication of a child having delayed spectacle correction or uncorrected refractive error, which includes part-time spectacle wear.
2. Provision of a range of appealing frames for children to choose from will be pivotal in improving spectacle compliance.
3. Proper maintenance of eye records of children with refractive errors at the school and the hospital level health management information system will ensure appropriate monitoring of children.
4. Budget allocation by line ministries for teachers training, provision of refraction and spectacle services to increase access to refractive services and stimulate greater participation by teachers in child eye health.

Pakistan

1. Need Regular eye examinations and spectacle wear particularly for girls should be promoted, as there appears to be an increased risk for myopia.
2. Provision and availability of eye care services closer to local communities.
3. Provision of advice and care instructions on how to care for spectacles, particularly during sporting activities.
4. Need to provide refresher training to ophthalmic clinical officers and optometrists in pediatric refraction
5. Deployment of ophthalmic clinical officers and district level health care facility to expand access.



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Appendices

Appendix 1

Recording Form 1

Name: _____

Class: _____

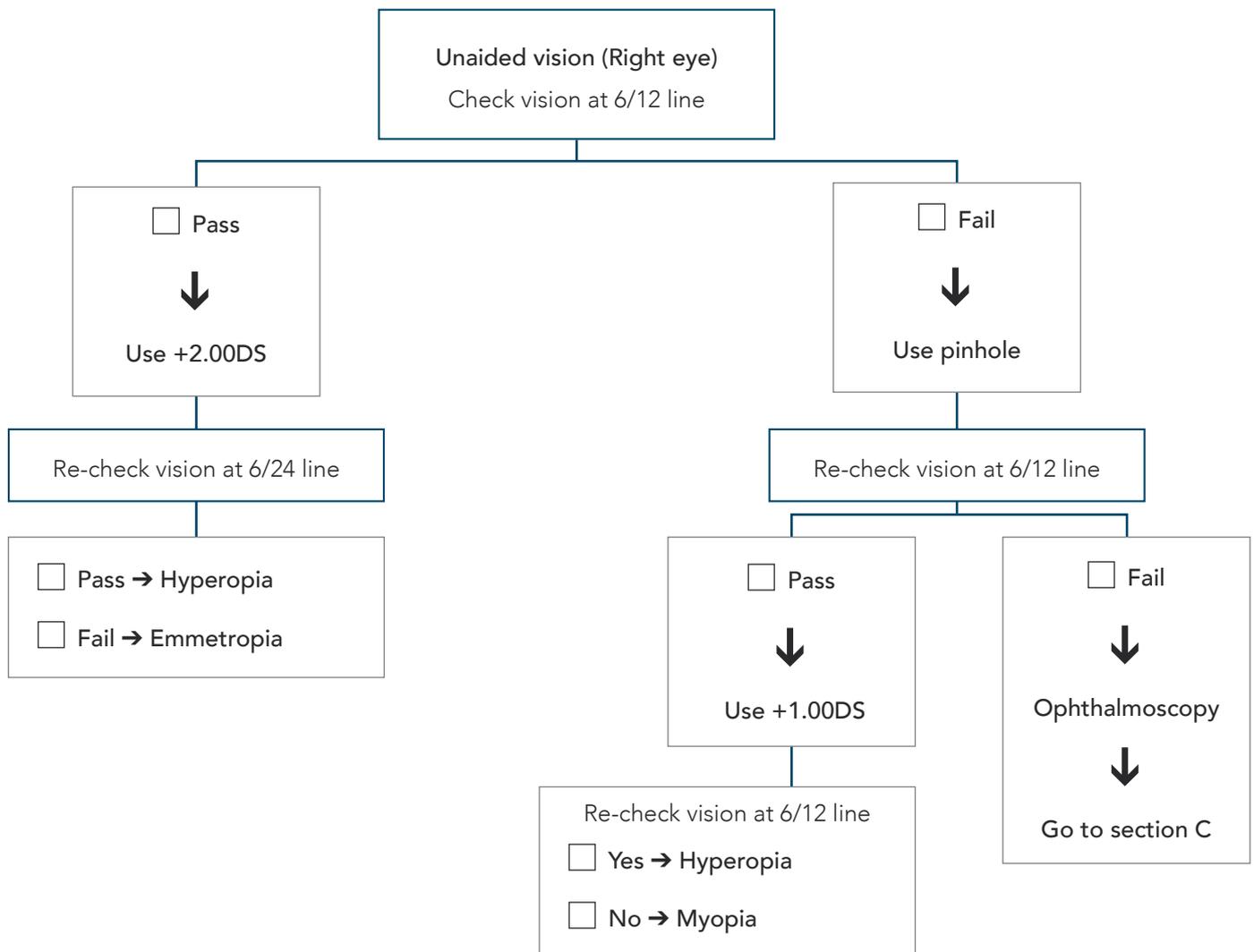
Unique study number:

Age: _____

Sex: Male Female

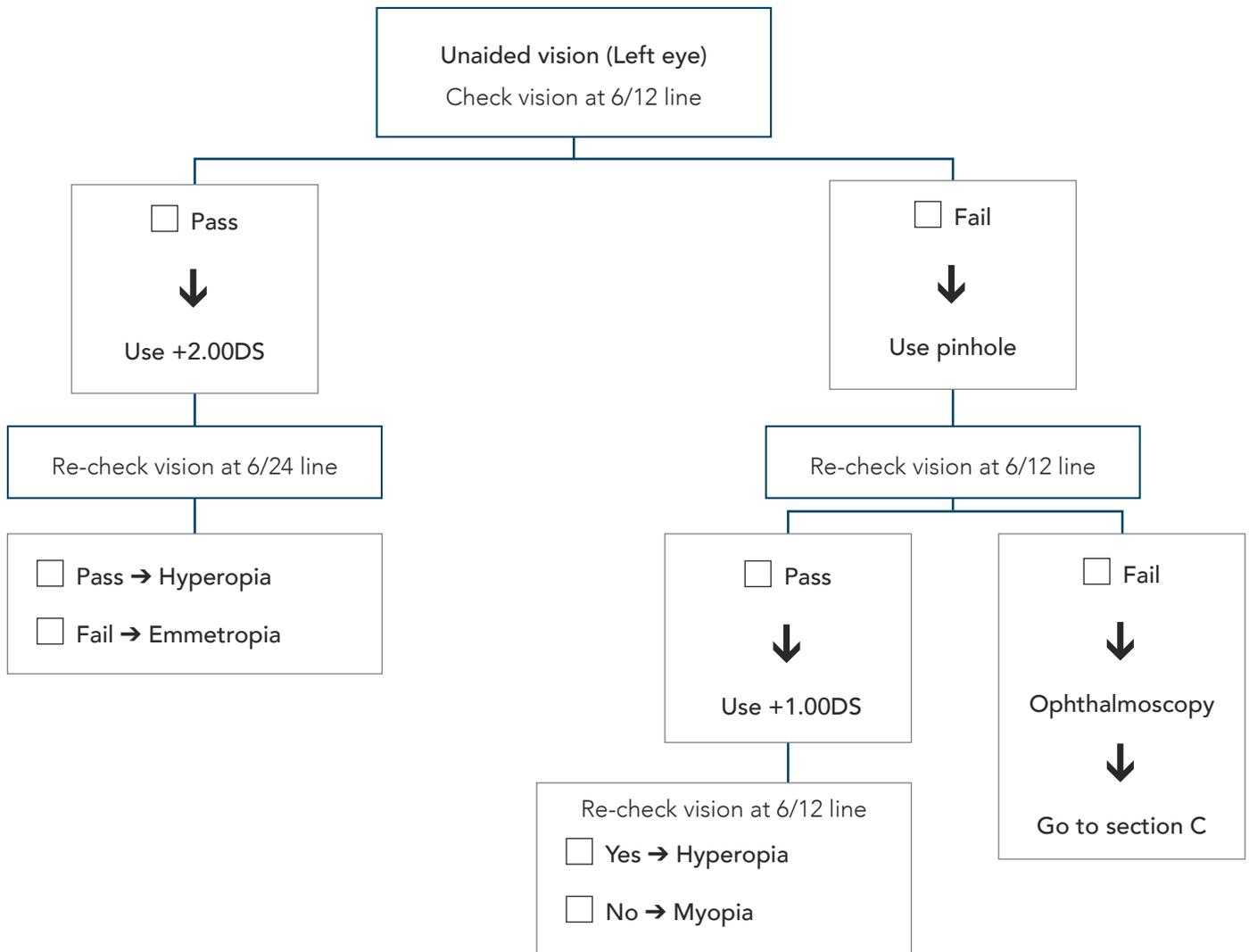
Section A

Mark 'X' at the appropriate option.



Section B

Mark 'X' at the appropriate option.



Section C

Ophthalmoscopy (LE)

Does the student have other ocular morbidity? Yes No → Emmetropia

If yes, specify: _____

Appendix 2

Spectacle Compliance Survey Questionnaire for School Children

Demography

- a. Child ID: _____
- b. Name of child: _____ Age: _____
- c. Gender: Male Female
- d. Name of School: _____ Grade: _____ Class: _____
- e. School Address: _____

- f. District: _____

No	Questions	Responses
1	Are you currently using the spectacle?	<input type="checkbox"/> Yes (Go to Q 2) <input type="checkbox"/> No (Go to Q 4)
2	How often do you use spectacles in a day? (Select one option only)	<input type="checkbox"/> Constantly wear glasses (Go to Q 5) <input type="checkbox"/> Only wear during school hours <input type="checkbox"/> Occasionally whenever I need to wear <input type="checkbox"/> I no longer wear them (Go to Q4) <input type="checkbox"/> Other (please specify) _____
3	What are the reasons for using spectacles less frequently? (Select maximum two main reasons)	<input type="checkbox"/> Friends tease when I wear them <input type="checkbox"/> Feel uncomfortable with spectacles <input type="checkbox"/> Do not like wearing them <input type="checkbox"/> Do not have to use often <input type="checkbox"/> Scratches on spectacles <input type="checkbox"/> Spectacles causes headache <input type="checkbox"/> Other (please specify) _____
4	What are the reasons for no longer wearing the spectacles? (Select maximum three main reasons)	<input type="checkbox"/> Did not see well with spectacles <input type="checkbox"/> Spectacles broken <input type="checkbox"/> Spectacles lost <input type="checkbox"/> Friends tease when I wear them <input type="checkbox"/> The spectacles were uncomfortable <input type="checkbox"/> Do not like to wear spectacles <input type="checkbox"/> Spectacles caused headache <input type="checkbox"/> Parents disapproved spectacles purchase after the first pair broke <input type="checkbox"/> Other (please specify) _____
5	Have you had an eye examination and/or purchased a new pair of spectacles after we examined you in 2011?	<input type="checkbox"/> Yes (Go to Q 6) <input type="checkbox"/> No
6	What is the main reason for purchasing a new pair of spectacles? (Select one option only)	<input type="checkbox"/> Did not see well with old spectacles <input type="checkbox"/> Spectacles broken so I purchased a new pair <input type="checkbox"/> Spectacles lost so I purchased a new pair <input type="checkbox"/> Doctor asked me to change <input type="checkbox"/> I did not like the frame of previous spectacles <input type="checkbox"/> Other (please specify) _____

Thank you for answering the questions.

Appendix 3

Spectacle Compliance Survey Questionnaire for Parents

Demography

- a. Child ID: _____ (As of the RARESC study data) (Interviewers to fill)
- b. Name of child: _____ Age: _____
- c. Gender: Male Female
- d. Fathers highest education: Primary school
 Secondary school
 College of Unveirsity
 No formal schooling
- e. Mothers highest education: Primary school
 Secondary school
 College of Unveirsity
 No formal schooling
- f. Fathers occupation: _____
- g. One or both parents where spectacles: Yes No
- h. Spectacles are worn for:
 Myopia (Short-sightedness)
 Hyperopia (Long-sightedness)
 Presbyopia (Near vision impairment)
 Do not know

No	Questions	Responses
1	Does your child currently wear spectacles?	<input type="checkbox"/> Yes (Go to Q 2) <input type="checkbox"/> No (Go to Q 4)
2	How often does your child use spectacles in a day? (Select one option only)	<input type="checkbox"/> Constantly wear glasses (Go to Q 5) <input type="checkbox"/> Only wear during school hours <input type="checkbox"/> Occasionally whenever I need to wear <input type="checkbox"/> I no longer wear them (Go to Q 4) <input type="checkbox"/> Other (please specify) _____
3	What are the reasons for using spectacles less frequently? (Select maximum two main reasons)	<input type="checkbox"/> Friends tease when I wear them <input type="checkbox"/> Feel uncomfortable with spectacles <input type="checkbox"/> Do not like wearing them <input type="checkbox"/> Do not have to use often <input type="checkbox"/> Scratches on spectacles <input type="checkbox"/> Spectacles causes headache <input type="checkbox"/> Other (please specify) _____
4	What are the reasons for no longer wearing the spectacles? (Select maximum three main reasons)	<input type="checkbox"/> Did not see well with spectacles <input type="checkbox"/> Spectacles broken <input type="checkbox"/> Spectacles lost <input type="checkbox"/> Friends tease when I wear them <input type="checkbox"/> The spectacles were uncomfortable <input type="checkbox"/> Do not like to wear spectacles <input type="checkbox"/> Spectacles caused headache <input type="checkbox"/> Parents disapproved spectacles purchase after the first pair broke <input type="checkbox"/> Other (please specify) _____
5	Have you taken your child for an eye examination and/or purchased a new pair of spectacles after we examined your child in 2011?	<input type="checkbox"/> Yes (Go to Q 6) <input type="checkbox"/> No
6	What is the main reason for purchasing a new pair of spectacles? (Select one option only)	<input type="checkbox"/> Did not see well with old spectacles <input type="checkbox"/> Spectacles broken so I purchased a new pair <input type="checkbox"/> Spectacles lost so I purchased a new pair <input type="checkbox"/> Doctor asked me to change <input type="checkbox"/> I did not like the frame of previous spectacles <input type="checkbox"/> Other (please specify) _____
7	Are you willing to pay for your child's eye examination in future and purchase new spectacles when it is required to change?	<input type="checkbox"/> Yes (Go to Q 6) <input type="checkbox"/> No
8	Will you mention reasons for the answer you have given to Q 7?	_____

Appendix 4

Participants Information Sheet Spectacle compliance among school children

Name of the Principal Investigator: [Insert name]

Name of the Organization: Brien Holden Vision Institute

Name of the Sponsor: World Bank and Brien Holden Vision Institute

Efforts are needed to improve the number of children who needs glasses wear them since this is may improve their school achievement. This question needs an answer to help make decisions on how we use our resource. Therefore, it is important to understand the compliance to spectacle use among schoolchildren in order to take the necessary steps for enhancing compliance to the spectacle use.

I, _____, am working with the Brien Holden Vision Institute and am conducting a survey on school children who have poor vision due to not having glasses.

Purpose: We want to know how many children have poor vision and needs a pair of glasses to correct them, and if provided glasses, are they wearing them 3 months after they are corrected and the reasons they are not wearing the glasses.

We invite your child to be part of this study which will mean giving him/her an eye examination and asking you and your child a few questions about wearing spectacles and eye problems. If your child has an eye problem and needed glasses, we will give the glasses, at no cost, by a team of eye care professionals as they visit your child in the school. If an eye disease is found, your child will be referred to the hospital eye clinic for more investigations so that appropriate treatment can be started. After three months, we will return to the school and re-examined your child whether they have any problems with their glasses.

Benefits: The eye screening will detect any eye problems you may have in your child's eyes. We will provide eye examination in the school and glasses to your child at no cost, if deemed necessary by the eye care professional. If medical/surgical, other treatment for your child's eyes are necessary, s/he will be referred for further investigation and treatment.

Confidentiality: Your answers and your child's answers to the questions and the results of your eye test will be kept confidential and will not be given to anyone outside the study. It will be used only for research purposes and combined with the results of the other participants so that we know what the spectacle use among the school children is. Your name or details or your child's name and details will never be used in any reports.

Right to refuse or withdraw: You and your child do not have to be part of the study, and if you agree to let your child to be part of the study, you can still decide not to take part at any stage. You and your child can decide not to answer any questions that are asked or have your child's eyes tested. However, as our study requires that we have the questions and eye test results to do our research, we hope that you and your child will be willing to answer the questions and have your child's eyes tested.

If you have any concerns you may ask now, or later. If you wish to ask later, you may contact [Insert details].

Appendix 5

Informed consent Certificate of consent

My child and I have been invited to take part in a research study on spectacle compliance among school children in Malawi. I have read the foregoing information, or it has been read to me. I have had an opportunity to ask questions, and any questions that I have asked have been answered to my satisfaction. I consent voluntarily for my child and myself to participate as a subject in this study and understand that I have the right to withdraw from the study at any time without in any way affecting my medical care.

Date: _____

If illiterate:

Name of independent Literate witness:

Signature: _____

Date: _____

(If possible, the witness should be selected by the participant and should have no connection to the research team.)

Name of Researcher:

Signature: _____

Date: _____

