A research report on the School Health Integrated Programming experience in Islamabad Capital Territory, Pakistan

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Sightsavers

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Abbreviations

BHVI - Brien Holden Vision Institute

COAVS - College of Ophthalmology & Allied Vision Sciences

EQ - EuroQol

EQ VAS - EuroQol visual analogue scale

FDE - Federal Directorate of Education

GBD - Global Burden of Disease

IAPB - International Agency for the Prevention of Blindness

ICT - Islamabad Capital Territory

LMICs - low- and middle-income countries

MSVI - moderate and severe vision impairment

OR - odds ratio

QoL - quality of life

RE - refractive error

SHIP - School Health Integrated Programming

Sd – Standard deviation

THRIVE - Tradespeople and Hand-workers Rural Initiative for a Vision-enhanced Economy

URE - uncorrected refractive error

VA - visual acuity

VI - visual impairment

WCO - World Council of Optometry

WHO - World Health Organization

Abstract

Uncorrected refractive error (URE) is a leading cause of visual impairment, affecting children's education, wellbeing and participation. This study examines the impact of spectacle use on the quality of life (QoL) and academic outcomes of public schoolchildren in Islamabad Capital Territory, Pakistan.

A quasi-experimental design was used in 14 schools, with 790 children aged 10 to 18 years. The study compared children with URE who received an eye examination and spectacles (Group 1), children with URE who received an eye examination and a prescription for spectacles (Group 2), and children without URE (comparator group), assessing QoL and academic performance at baseline and at the six-month follow-up.

Results showed significant QoL improvements due to vision correction with spectacles correction, especially among children that had good compliance with spectacle use. Academic performance also improved in children with spectacle correction, with the greatest gains observed in children who consistently wore their spectacles. High parental willingness to pay for future eye exams and spectacles was noted, though cost was identified as a potential barrier to future eye examination and spectacle purchasing.

The findings emphasise the importance of school-based eye health programmes to identify and address refractive errors (REs) and other eye conditions in schoolchildren. The evidence suggests that vision correction and spectacle use can improve children’s quality of life and educational outcomes. Efforts to ensure compliance with spectacle use among children and consideration of the affordability of vision screening and spectacles are crucial to maximise the benefits from such interventions. Future research should explore the long-term impacts of children’s spectacle use and consider suitable strategies to enhance compliance.

Introduction

Refractive errors (REs) occur when the shape of the eye prevents light from focusing properly on the retina, resulting in blurry vision. Myopia (difficulty seeing far away objects), hyperopia (difficulty seeing nearby objects), astigmatism (blurred and distorted objects at any distance) and presbyopia (age-related difficulty seeing close-up) are the common types of REs (1).

UREs are the leading cause of visual impairment in adults and children, accounting for 53.4% of all cases of moderate and severe vision impairment (MSVI) globally (2). In 2020, 3.7 million people were blind and 157 million had MSVI due to URE, a 21.8% increase in blindness and 72% increase in MSVI since 2000 (2). The number of people with URE is expected to increase further, with some projections suggesting that myopia prevalence will reach 52% of the world's population by 2050 (3).

South Asia[1] is home to 23% of the world's population, but 34% (53.9 million) of the global burden of MSVI due to URE, with an age standardised prevalence of 3.4%, higher than in any other region in the world (4). About one in three of all children and adolescents with myopia, which tends to start in childhood and worsen with age, live in South Asia (5).

URE is a major public health problem in Pakistan. The results of the Spectacle Compliance among School Children in Pakistan study, commissioned and supported by the World Bank, indicated that the prevalence of vision impairment and refractive error in children was 5.4% and 5.3%, respectively (6). Prevalence of myopia was higher among older children (8.9% in

[1] The Global Burden of Disease (GBD) super region of South Asia includes Bangladesh, Bhutan, India, Nepal and Pakistan.

those aged 12 to 16 years old) and there were 2.4 times more girls who had myopia than boys. Given that the population of Pakistan is 241.5 million and there are 85.2 million 5 to 19 year olds (7), a significant number of school-aged children in the country are myopic, and many of them do not have access to diagnosis and treatment services (2).

There is compelling evidence that shows that better eye health contributes to achieving many of the Sustainable Development Goals (SDGs), including those on poverty, work productivity, health, education and equity (4). The burden of unaddressed visual impairment can hamper the achievement of these SDGs, and has significant economic costs estimated at $411 billion of lost productivity annually (8).

URE, like many other causes of visual impairment, has profound implications for many aspects of an individual's life. While refractive errors cannot be prevented, they can be addressed by simple, cost-effective interventions. Addressing visual impairment caused by URE can improve educational outcomes, increase economic opportunities and enhance wellbeing and quality of life (9-12).

The World Health Organization (WHO) has noted that in light of "the increasing number of children and adolescents with refractive error, high-quality and cost-effective school-based eye care linked to service provision is of the utmost importance" (13). Implementation of school-based programmes is supported by the inclusion of spectacles in the WHO Priority Assistive Products List.

Despite this global political commitment, data on the uptake and impact of spectacles among school-age children remains limited, particularly in low and middle income countries (LMICs) (14). Data that does exist is mostly related to the impact on education attainment and comes largely from North America and China. It shows that children who receive spectacles through school-based eye health programmes do achieve better academic test scores. However, the

positive effects observed in the first year of spectacle use seem to decrease over time. There is also some evidence on the impact of spectacle use on children's aspirations, school dropout and mental health (11, 15-25) and limited evidence of the impact of spectacle provision on children's quality of life (26). There are also gaps in knowledge around operational aspects of school-based eye health programmes, specifically compliance with spectacles, usability and the effect of user fees (26).

Given these limitations in evidence, it is not surprising that there is a paucity of data on the uptake and impact of vision correction and spectacle use among school-age children in Pakistan. A few studies that exist show a varied picture. For example, Latif et al (2022) investigated the academic performance before and after vision correction with spectacles in schoolchildren in Lahore and found a significant increase in the average academic scores after correction (27). Khan (2023) found that compliance with spectacles among children was low due to a number of reasons, including spectacle breakage, loss, unaffordability, cosmetic reasons, social stigma and inappropriate correction (28). Anwar (2017) had similar results and showed that the use of spectacles was positively associated with age, type of refractive error, father's education and parent's occupation; and the main reasons of non-compliance were spectacle breakage, loss, forgetting to wear, peer pressure, disliking spectacles and inability of the family to pay (29). With regards to quality of life (QoL), we have not found any published study on the impact of spectacle use on the quality of life of schoolchildren in Pakistan (28, 29). This operational research sought to address the limited evidence around the spectacle use by schoolchildren in Pakistan. The study was integrated in a large school-based eye health programme delivered in Islamabad Capital Territory (ICT).

The overall aim of the study was to examine the uptake, compliance and impact of provision of spectacles to school-age children and generate evidence to support the delivery of a school-based eye health programme at scale. We were particularly interested the impact of

spectacles on children's quality of life and in compliance with spectacles in different programme delivery models, such as refraction, prescription and provision of free spectacles in school compared to refraction and prescription only. The study addressed the following research questions:

1) What is the compliance with spectacles among school-aged children, who receive free spectacles after refraction compared to those who receive refraction and a prescription only?
2) What is the quality of life of children with RE compared to children without RE and how it changes after RE correction and provision of spectacles?
3) What is the impact of vision correction and provision of spectacles on academic attainment of school-age children?

Methods

The study was nested in the School Health Integrated Programming (SHIP) project supported by international development organisation, Sightsavers, delivered in government schools in Islamabad Capital Territory (ICT), Pakistan.

Project description

The project was implemented in partnership with the Federal Directorate of Education (FDE) and targeted children aged 5 to 18 years attending government schools. The project identified children with REs and other eye conditions and provided them with quality spectacles and follow-up management, as needed. The project started in September 2019 and ended in February 2024.

SHIP implementation consisted of optometrists training teachers in how to conduct a simple vision screening. Teachers then referred children who failed the vision screening (vision worse than 6/9 in either eye) to mobile refraction teams that included qualified optometrists. The mobile refraction teams conducted eye examinations, including refraction, following national regulations and SHIP guidelines that are aligned with International Agency for the Prevention of Blindness (IAPB) school eye health guidelines (30). Any child found to have other ocular conditions that could not be corrected with spectacles were either immediately treated by the optometrists or referred to appropriate eye health facilities for treatment. Children and parents were made aware of any vision problems following screening and refraction. In all schools participating in the SHIP project, teachers were encouraged to ensure children who had spectacles wore them as required.

The SHIP project was implemented in all 423 government schools in ICT. During the lifetime of the project, 791 teachers were trained to conduct vision screening, 170,348 children were

screened by teachers, and 13,703 children received an eye examination by an optometrist. 10,203 children (6% of those screened) were found to have UREs and received spectacles. In addition, 4,911 teachers received an eye examination, and 324 teachers received spectacles.

Study settings

The research was implemented in the last phase of the project between September 2023 and May 2024. Study participants were recruited from the 14 single-sex schools scheduled for SHIP interventions in this period. The schools were in Bharakahu, Urban 1, and Urban 2 areas of ICT[2].

This study utilised a quasi-experimental design. Fourteen study schools were conveniently allocated to two groups in a chronological order based on the project schedule. The difference between the two groups was in the provision of spectacles. In Group 1 schools, trained teachers conducted simple vision screening and referred children who failed screening to mobile optometrist teams who examined and refracted them. If a child had uncorrected visual acuity of less than 6/9 in either eye and the clinician recommended spectacles, they received a spectacle prescription and were offered spectacles free of charge. Most of the children were given spectacles immediately, but a small number of children who needed customised spectacles received them a few days after refraction. A letter informing parents about the free provision of spectacles and the child's prescription was sent to their home.

[2] The Federal Directorate of Education (FDE) has divided 423 schools into six sectors based on their geographical locations.

Group 2 included schools where children with refractive errors were provided with a prescription for spectacles only. Following vision screening by trained teachers, children who failed the screening test were seen by a qualified optometrist. If a child had an uncorrected visual acuity (VA) of less than 6/9 in either eye or the clinician recommended spectacles, they received a prescription for corrective spectacles. A letter informing parents of the child's prescription and information where spectacles could be bought was sent. At the end of the study, free spectacles were provided to any child that received a prescription but did not purchase spectacles during the study period. However, this was not announced until the end of the trial.

Data on children's QoL and academic outcomes was collected in all 14 schools. To answer research questions two and three, the data was collected before the spectacles were prescribed (baseline) and between five and seven months after the spectacle prescription/ provision (endline). For comparative purposes, data on QoL and academic outcomes was also collected from children without RE (comparison group) in both Group 1 and Group 2 schools.

Study population and sampling

The population included in this study were children enrolled in grades 2 to 12 in selected study schools participating in the SHIP project between September 2023 and May 2024. Children at the selected schools were eligible if: they were in grades 1 to 12; the child provided assent to participate; and the parent/guardian of the child provided consent to participate.

All children diagnosed with RE, and recommended spectacles were eligible for inclusion in Group 1 and Group 2, if their parents provided consent and the children provided assent. A sample of children for the comparison group was selected purposively from the population of

children identified as having good vision. When one child with URE was selected in a study, the next child in the class, examined by the optometrist and without RE, was asked to participate in the comparator group. This sampling method was used to have similar proportion in terms of age, grade and school in both groups and the comparator. Data on QoL and academic outcomes of these children was collected at the same time as for children with RE at baseline and endline. The number of children enrolled in the comparator group was aimed to be equal to the intervention groups, as advised in the literature (31).

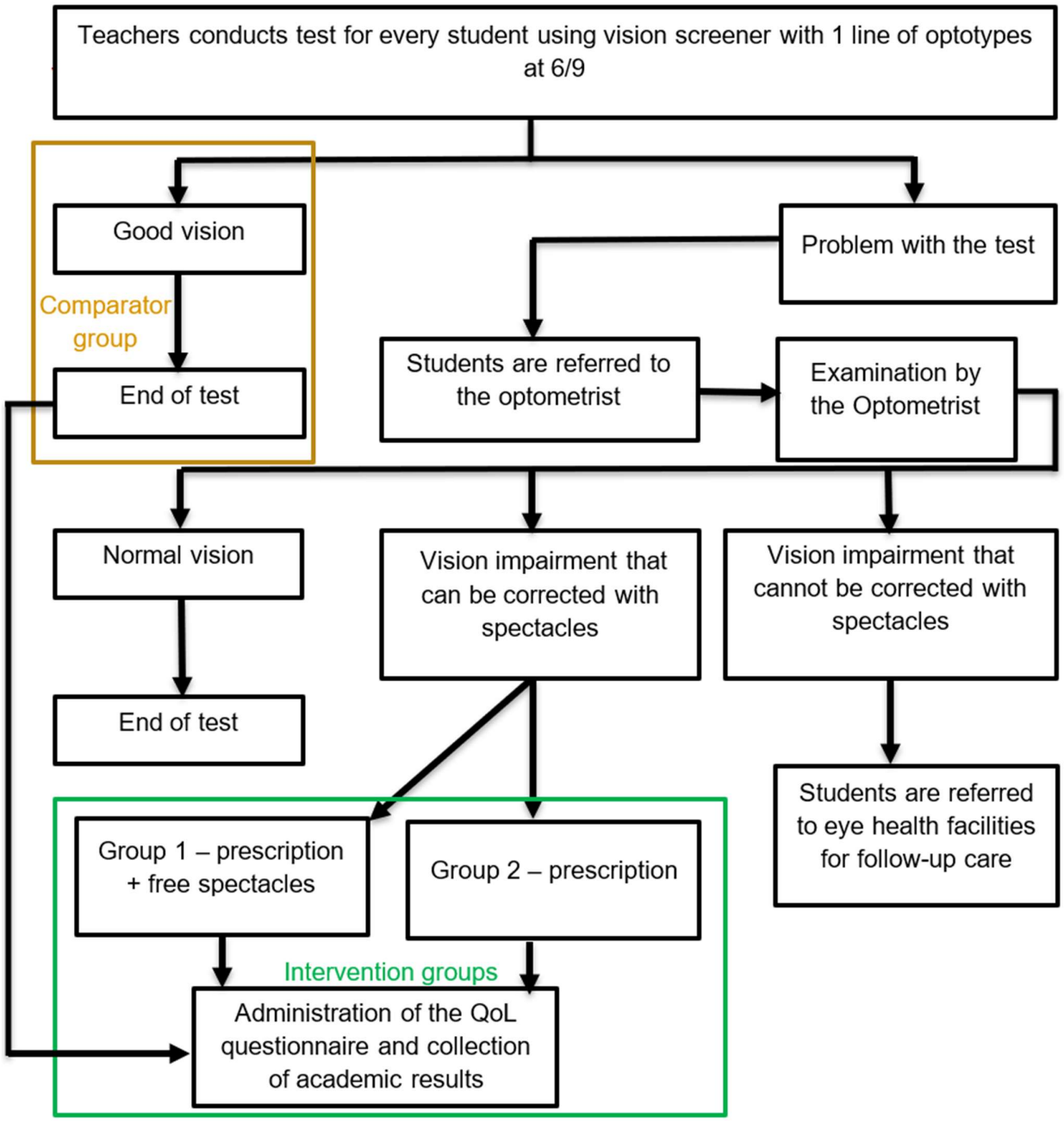


Figure 1: Summary of SHIP implementation process

Data collection and management

The study used several data collection tools. Child socio-demographic data, including age, sex and grade, was collected for all participants. QoL was assessed using the child-friendly version of the EuroQol instrument called EQ-5D-3L-Y (formerly EQ-5D-Y). The EQ-5D-3L-Y is a commonly used, preference-based measure designed to elicit health-related QoL among children and adolescents. The tool was introduced by the EuroQol Group in 2009 and consists of two pages: the EQ-5D descriptive system and the EQ visual analogue scale (EQ VAS). We chose this tool because it was standardised, comparable, free to use and rapid to implement, with only five multiple choice questions plus a visual analogue scale question. The EQ-5D scale asks questions regarding mobility, self-care, doing usual activities, having pain or discomfort and feeling worried, sad or unhappy. Each dimension has three response levels: no problems, some problems and a lot of problems. The respondent is asked to indicate his/her health state by ticking the box next to the most appropriate statement in each of the five dimensions. This answer results in a one-digit number that expresses the level selected for that dimension. The digits for the five dimensions can be combined into a five-digit number that describes the young person's health state. The EQ-VAS tool allows the child to self-rate their health on a scale from 0 to 100 using a vertical visual analogue scale where the endpoints are labelled "The best health you can imagine" and "The worst health you can imagine". The EQ-5D-Y-3L proved its feasibility, validity and reliability (32, 33). EQ-5D-Y-3L is available in more than 150 languages and can be administered in different formats. Using this simple tool in our study schools meant that children and teachers were not disrupted significantly during their school day.

At baseline, all selected children with RE and a sample of children with normal vision were asked, upon parental consent, to participate in the study. Each child enrolled into the study was administered the QoL questionnaire. The questionnaire was administered by phone

using data collectors as proxies and using the CommCare application (34). It took on average four minutes to complete. At the follow-up (between five and seven months later), the QoL questionnaire was again administered to all participants present during the assessment period. During the follow-up, children were also asked to respond to a simple questionnaire about spectacle ownership and use (Appendix S1). Children were asked if they owned spectacles, how often they used them and if they wore them as recommended. If they did not own a pair of spectacles, they were asked why they didn't. In addition, the parents/guardians of children with REs in both intervention groups were also interviewed over the phone using a short questionnaire, which asked about the use of spectacles by their children. This data was used to measure spectacle availability and compliance.

Compliance, defined as regular use of spectacles, can be assessed by observation or by questioning users. Observation of children's spectacle use at school may have caused disruption to lessons and to the children and teachers, and observation at home was not practical. Therefore, for the purpose of this study, we defined that the child complied with the spectacle use if i) they reported having a pair of spectacles; and ii) the child said that they wore their spectacles as recommended by the optometrist, or more often than recommended. Our original intention was to verify the child's response with the response of their parent to the question "How often do they wear spectacles?". However, due to a substantial number of parents who could not participate in the phone interview (n=102), we decided to measure compliance based on the child report only.

All data collection was led by a team of trained enumerators. Data was collected in Urdu directly after eye examination. Telephone interviews with the parents were recorded using CommCare application on smartphones. Data on children's academic outcomes was based on monthly English and Maths test results. This data was extracted from the school records by the study coordinator and in collaboration with the Administrative Education Officer.

Depending on the grade of the child and the school, the scoring system was different (0 to 20, 30, 50, 75 or 100 points) and we used the average of all Maths and English tests in the reporting months.

Statistical analysis

Descriptive statistics were calculated for the baseline characteristics of study participants. This included mean and standard deviation for continuous variables (for example, age, QoL scores) and frequency distributions for categorical variables (such as sex, severity of visual impairment). Chi-square tests of independence, or Fisher's exact test when sample size was small, were conducted to examine the relationship between the outcomes (ownership and compliance) and explanatory variables for dichotomous categorical variables (35).

Compliance with spectacles was analysed as a binary variable (compliance and non-compliance), as per definitions explained above, and using a univariate and multivariate logistic regression assessed for association with children's socio-demographic characteristics (sex, age and rural or urban residency, parents' education and parents' occupation).

Severity of visual impairment was classified using the World Council of Optometry (WCO) for spherical prescription as follows; low hypermetropia (+1.00 to <+2.00), moderate-high hypermetropia (+2.00 to <+4.50), high hypermetropia (≥+4.50), myopia (-0.50 to <-5.00) and high myopia (-5.00 or less). However, due to a very small number of children with hypermetropia and high myopia and VA data missing for 61 children with RE, we analysed this variable as binary, RE present or not (for instance, intervention group or comparator group).

QoL was first visually analysed using the descriptive system of five dimensions, comparing the percentage of children stating that they have a lot of problems at baseline and endline.

Afterwards, we wanted to calculate a summary score derived from the five dimensions. Indeed, the EuroQol Group has a protocol for valuing EQ-5D-Y-3L health states and creating standard value sets for the instrument to facilitate international comparisons. However, no standard value sets were available for Pakistan at the time of the study, and to calculate utilities we used the value set for Indonesia, as it was considered geographically closest and the most similar setting in terms of national income level (36). The visual analogue scale was combined to the utilities calculated above, to generate a composite utility score which was used to analyse children's self-reported QoL and as the main QoL outcome, given the non-existence of value sets for Pakistan to ensure that the unique health perceptions and experiences of the local population are reflected.

To assess the effect of providing prescription/spectacles on children's QoL, we compared the change in QoL between baseline and endline for both the comparator group and the intervention groups. The first analysis consists of comparing graphically, including generate confidence interval at 95% using the *ciplot* command, children with corrected vision that used their spectacles for five to seven months, with children that did not have any visual impairment, to control for QoL or academic performance changes. We also then compared children that complied with their treatment (for example, intervention) and those who did not (for example, control). We conducted a univariate regression analysis adjusting for sex (because it is correlated with QoL as observed in the literature and confirmed in our sample) and used the difference-in-difference approach (37-39). Finally, using the same approach, a multivariate analysis using regression, accounting for socio-demographic variables as potential predicators for both outcomes based on univariate results, was conducted (40).

To address the issue of missing data related to parents' education and occupation, a sensitivity analysis was conducted. This analysis involved performing a multivariate analysis, with compliance as an outcome, including a missing data category for the variables where

observation was missing, assessing its impact on the results (such as father and mother's occupation and education level). The findings indicated that the inclusion of a missing category for education and occupation variables significantly influence the results, so we decided to analyse them separately and exclude them from the multivariate analyses.

For academic performance, each child's English and Maths test results have been standardised for each grade and school, using z-scores (with a mean of 0 and standard deviation of 1). Academic performance could only be analysed descriptively from October 2023 to January 2024 (n=299), due to a limited number of test results 46.8% (n=299). It was also limited to four months because February and March observations collected represented less than 25% of the 638 children.

All statistical analyses were conducted using Stata version 18.5.

Ethical considerations

Ethical approval was obtained from the College of Ophthalmology & Allied Vision Sciences (COAVS) [protocol #265/23, 24/02/2023]. Informed assent was obtained from all study participants and informed consent was obtained from their parents/guardians. Information about the study was provided in Urdu and participants had an opportunity to ask questions. Information about the study was provided in such a way as to avoid the Hawthorn effect, when participants behave differently being under observation. Participants (students, parents and teachers) were told that the study was about school-based eye care, but no information on the study design or specific outcome variable was provided. All children who required spectacles but did not have them at the end of the study were provided with a pair of spectacles free of charge.

Results

Participant characteristics and attrition

A total of 790 children were recruited at baseline for the study across 14 schools at baseline. 334 children were girls (42.3%), and the mean age was 14 years old (standard deviation (sd) 2.1). Following the examination by the optometrist, 388 children were confirmed to have RE and required spectacles and 402 children were found to have normal vision and were recruited in the comparison group.

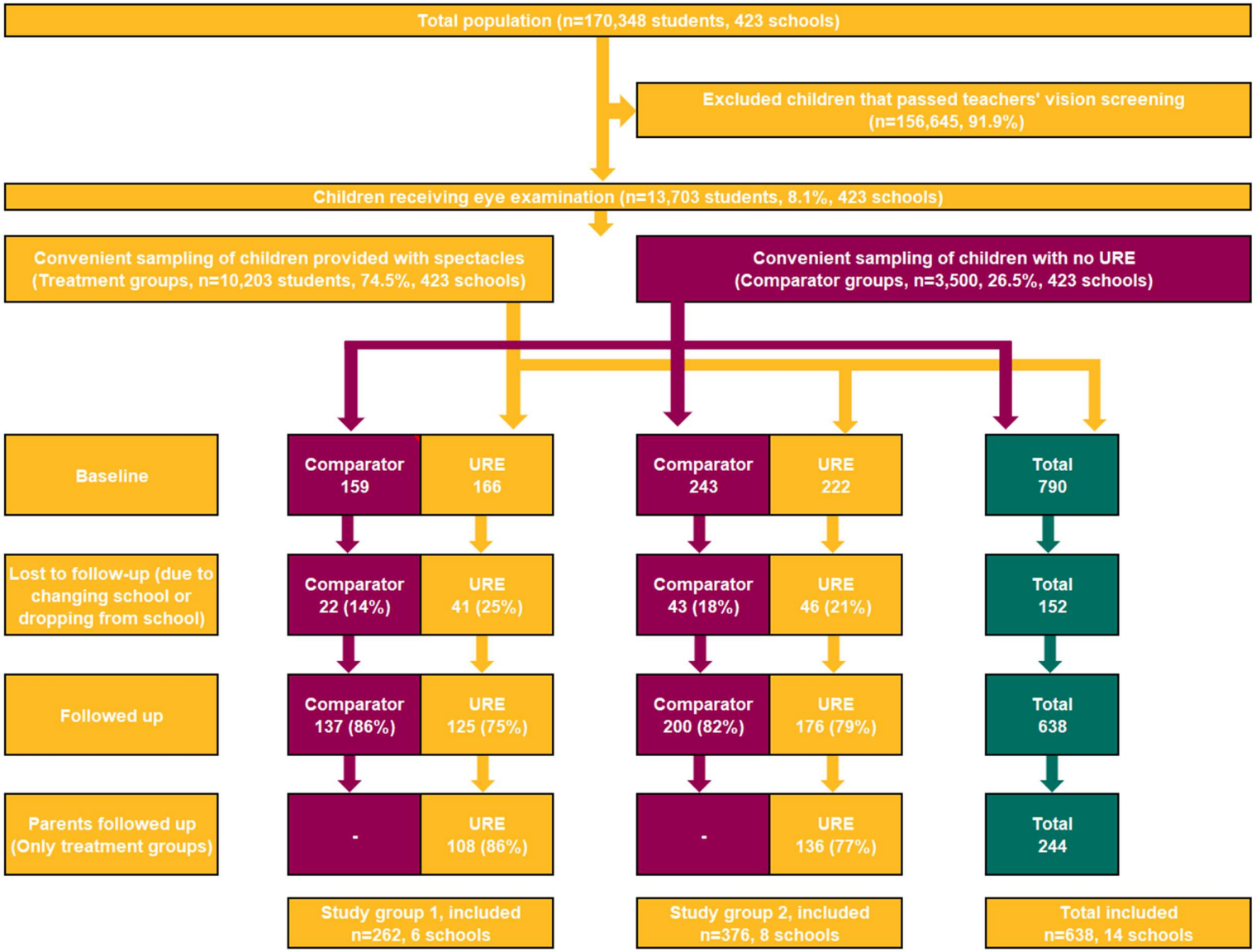


Figure 2: Flow diagram of children enrolment

Among children with URE (n=388): 166 children were in Group 1 and received a prescription and a free pair of spectacles on the day or soon after the refraction; 222 children were in Group 2, and they received a prescription only, at first. After the follow-up phase, children in Group 2 who did not own spectacles received a free pair.

The attrition rate was 19.3%, with the highest attrition observed in Group 1, 19.1% (Figure 2). The main reasons for attrition were children who changed schools and their absence on the day of the data collection due to the end of year exams.

As a result, the endline data was collected from 638 children (Table 1). The mean age of participants was 13.8 years old (sd 2.1) with more male students being interviewed (60.3%) than females (39.7%). A total of 301 children were diagnosed with refractive error (RE), including 125 in Group 1 and 176 in Group 2. Additionally, 337 children with good vision were included in the comparison group. Among those with RE, 75.4% (n = 233) had myopia, six children (2%) had high myopia, six (2%) had hypermetropia, and one child (0.3%) had high hypermetropia. Refraction results were missing for 61 children (Table 1). Most children were from the schools in rural areas of ICT (66.9%).

Parent interviews were conducted with a total of 244 parents of children with RE; these included 108 parents from Group 1 and 136 parents from Group 2 (Figure 2 and Appendix S2).

Table 1: Children's characteristics at endline

	Comparator group 1	Treatment group 1	Comparator group 2	Treatment group 2	Total
N (%)	137 (21.5%)	125 (19.6%)	200 (31.3%)	176 (27.6%)	638 (100.0%)
Sex					
Male	84 (61.3%)	73 (58.4%)	115 (57.5%)	113 (64.2%)	385 (60.3%)
Female	53 (38.7%)	52 (41.6%)	85 (42.5%)	63 (35.8%)	253 (39.7%)
Age group					
10-15	122 (89.1%)	105 (84.0%)	141 (70.5%)	115 (65.3%)	483 (75.7%)
>15	15 (10.9%)	20 (16.0%)	59 (29.5%)	61 (34.7%)	155 (24.3%)
Grade group					
Primary school	33 (24.1%)	17 (13.6%)	17 (8.5%)	8 (4.5%)	75 (11.8%)
Middle school	69 (50.4%)	67 (53.6%)	105 (52.5%)	77 (43.8%)	318 (49.8%)
Lower secondary	35 (25.5%)	37 (29.6%)	32 (16.0%)	50 (28.4%)	154 (24.1%)
High school	.	4 (3.2%)	46 (23.0%)	41 (23.3%)	91 (14.3%)
Severity					
No impairment	137 (100.0%)	.	200 (100.0%)	.	337 (52.8%)
Myopia	.	102 (81.6%)	.	125 (71.0%)	227 (35.6%)
High myopia	.	2 (1.6%)	.	4 (2.3%)	6 (0.9%)
Hypermetropia	.	1 (0.8%)	.	5 (2.8%)	6 (0.9%)
High hypermetropia	.	.	.	1 (0.6%)	1 (0.2%)
Missing	.	20 (16.0%)	.	41 (23.3%)	61 (9.6%)
School zone					
Urban	.	.	104 (52.0%)	107 (60.8%)	211 (33.1%)
Rural	137 (100.0%)	125 (100.0%)	96 (48.0%)	69 (39.2%)	427 (66.9%)

Availability and compliance with spectacles

Of the 301 school children with endline data, 41.5% (125) were in Group 1 and 58.5% (176) were in Group 2. Across both groups, 60.8% reported having spectacles five to seven months after correction (Table 2). The difference in ownership of spectacles between the two groups was statistically significant (p <0.005). In Group 1, where children received a prescription and a free pair of spectacles, 82.4% reported owning spectacles. In contrast, in Group 2, where children received a prescription only, 47.2% of the children reported owning spectacles. The overall compliance with spectacle use was 42.5%, with significantly higher compliance in Group 1 (53.6%) compared to Group 2 (34.7%) (p <0.005). As expected, providing free spectacles immediately after the eye examination significantly increases the likelihood of children owning spectacles and therefore increased the likelihood of using them.

Table 2: Spectacle ownership and compliance by study group

Group	Group 1 n (%)	Group 2 n (%)	p-value
Own spectacles*			**0.000**
No	22 (17.6%)	93 (52.8%)	
Yes	103 (82.4%)	83 (47.2%)	
Compliance*			**0.001**
No	58 (46.4%)	115 (65.3%)	
Yes	67 (53.6%)	61 (34.7%)	

The multivariable logistic regression model suggested higher probability of owning spectacles was, as expected, associated with free provision of spectacles (odds ratio (OR) = 1.554, Table 3). Despite controlling for the intervention group, girls are approaching, but not reaching, a significant association with a lower probability of owning a pair of spectacles (OR=0.488, p-value=0.097). However, grade groups and school location showed no significant association, with p-values at 0.485 and 0.518, respectively.

Table 3: Factors associated with ownership of spectacles – Multivariable logistic regression

	Multivariable model	
Variables	**Odds ratio [95% confidence interval]**	**p-value**
Sex (Ref. boys)		
Girls	0.488 [0.209 – 1.137]	0.097
Grade group (Ref. grade 1 to 5)		
Grade 6 to 8	0.673 [0.222 – 2.044]	0.485
Grade >10	1.445 [0.473 – 4.408]	0.518
School location (Ref. rural)		
Urban	1.033 [0.374 – 2.852]	0.950
Study group (Ref. Group 1)		
Group 2	0.1554 [0.071 – 0.339]	**0.000**

Among 22 children who did not have spectacles in Group 1, half (n=11) said that they had lost or broken their spectacles; four (18.2%) said they did not need them. Three (13.6%) said they had not yet received their spectacles, reflecting a delivery challenge corrected after follow-up. In Group 2, among 93 children who did not own spectacles: 26 children (28.0%) said they had not obtained/purchased spectacles; nearly a quarter (23.7%, n=22) said they did not need spectacles; 13 (14.0%) children said they could not afford them; and nine (9.7%) had lost or broken them (Table 4).

Table 4: Reasons for not owning spectacles

Reason for not owning spectacles	Group 1 n (%)	Group 2 n (%)	p-value
Total number of children not owning a pair of spectacles	**22 (19.1%)**	**93 (80.9%)**	**0.005**
Did not get the spectacles yet	3 (13.6%)	26 (28.0%)	
I don't think I need to wear spectacles	4 (18.2%)	22 (23.7%)	
Broken or lost	11 (50.0%)	9 (9.7%)	
Affordability	1 (4.5%)	13 (14.0%)	
Child or parent not informed about spectacles	1 (4.5%)	8 (8.6%)	
Don't like spectacles	1 (4.5%)	5 (5.4%)	
Parents disapprove of spectacles	1 (4.5%)	3 (3.2%)	
Other eye treatment or correction	0 (0.0%)	4 (4.3%)	
Other	0 (0.0%)	3 (3.2%)	

When asked whether they knew when to wear the spectacles, 68.0% of the children who were prescribed spectacles in Group 1 and 51.1% in Group 2 said they had to wear them at any time (Table 5). For children that owned spectacles only, 72.8% in Group 1 and 68.7% in Group 2 said they had to wear them at any time. The proportion of children who said they could not remember was 12.8% of children in Group 1 and 11.9% in Group 2 in all the children that were prescribed spectacles, and 12.6% and 8.4%, respectively, in children that owned spectacles.

Table 5: Children's understanding of when to use spectacles

Variables	Group 1 n (%)	Group 2 n (%)	p-value
All children in group:			
Have you been told when to wear your spectacles?	n=125	n=176	**0.001**
At any time	85 (68.0%)	90 (51.1%)	
No one told me	12 (9.6%)	44 (25.0%)	
I don't remember	16 (12.8%)	21 (11.9%)	
When reading	4 (3.2%)	15 (8.5%)	
Occasionally/whenever I feel the need	8 (6.4%)	6 (3.4%)	
Children that owned spectacles only:			
Have you been told when to wear your spectacles?	n=103	n=83	0.252
At any time	75 (72.8%)	57 (68.7%)	
No one told me	6 (5.8%)	9 (10.8%)	
I don't remember	13 (12.6%)	7 (8.4%)	
When reading	3 (2.9%)	7 (8.4%)	
Occasionally/whenever I feel the need	6 (5.8%)	3 (3.6%)	

The proportion of those who had not been told how to use spectacles was substantially higher in all children in Group 2 than Group 1 (25.0% vs 9.6%, respectively), but among those that owned spectacles 5.8% in Group 1 and 10.8% in Group 2 said they had not been told when to wear spectacles (Table 5).

In Group 1, for children that owned spectacles 81.6% (84) reported being told to wear spectacles at any time, when reading or whenever they felt the need and 18.4% (19) reported not being told or couldn't remember when to wear them. This was similar in Group 2, with 80.7% (67) knowing when to wear them and 19.3% (16) either not being told or not remembering when to wear them.

For those that knew when to use their spectacles, 73% (61) wore them as recommended in Group 1 and 78% (52) in Group 2, with no significant differences between intervention groups (Table 6).

For children that owned spectacles but reported not being told or couldn't remember when to wear them, 26.3% (5) did not wear them at any time and 73.8% (14) wore their spectacles at some point during the day in Group 1. The corresponding figures for Group 2 are 25.0% (4) of children did not wear them at all and 75.0% (12) wore them at some point.

In Group 1, 67 (65.0%) of the 103 children that owned spectacles used them as recommended or more often (constantly). In Group 2, of the 83 children that owned spectacles, 61 (73.5%) said they used them as recommended or more often.

Table 6: Children's wearing of spectacles among children that owned them

Variables	Group 1 n (%)	Group 1 n (%)	p-value
Are you wearing your spectacles as recommended? (if owned spectacles)	n=84	n=67	**0.482**
Yes	61 (72.6%)	52 (77.6%)	
No	23 (27.4%)	15 (22.4%)	
If not, how often do you wear your spectacles? (if owned spectacles)	n=23	n=15	**0.075**
Don't wear at all	6 (26.1%)	6 (40.0%)	
Occasionally	7 (30.4%)	4 (26.7%)	
Constantly	0 (0.0%)	3 (20.0%)	
During school hours	6 (26.1%)	2 (13.3%)	
Other	4 (17.4%)	0 (0.0%)	
If you do not remember or you were never told, how often do you wear your spectacles? (if owned spectacles)?	n=19	n=16	**0.987**
Don't wear at all	5 (26.3%)	4 (25.0%)	
Occasionally	4 (21.1%)	3 (18.8%)	
Constantly	6 (31.6%)	6 (37.5%)	
During school hours	4 (21.1%)	3 (18.8%)	

The multivariable analysis (Table 7) showed that when controlled for mode of spectacle provision (study group at p-value=0.016), none of the socio-demographic characteristics are significantly associated with compliance. Sex is approaching but does not reach a 10% confidence interval (p-value=0.107), showing a trend but not achieving statistical significance.

Table 7: Factors associated with compliance with spectacles – Multivariable logistic regression

	Multivariable model	
Variables	**Odds ratio [95% confidence interval]**	**p-value**
Sex (Ref. boys)		
Girls	0.569 [0.287 – 1.130]	0.107
Grade group (Ref. grade 1 to 5)		
Grade 6 to 8	0.471 [0.184 – 1.207]	0.117
Grade >10	0.673 [0.262 – 1.730]	0.411
Location (Ref. urban)		
Rural	0.899 [0.357 – 2.262]	0.820
Study group (Ref. Group 1)		
Group 2	0.408 [0.197 – 0.847]	**0.016****

The reasons for not wearing spectacles among participants who said they never wear them, despite receiving a recommendation to and owning a pair of spectacles, are summarised in Table 8. Overall, the most common reason reported was that children did not liking using the spectacles, which was cited by 26.1% of participants in Group 1 and 20.0% in Group 2. A smaller proportion of participants reported experiencing headaches, four participants in

Group 1 and one in Group 2. Less common reasons included 'not feeling the need to use spectacles', two children in Group 1 and one in Group 2. 'Concerns about appearance' was also mentioned by two participants in both groups; so were "Do not feel comfortable wearing them". Overall, the Fisher's exact test showed no association between reasons for not wearing and intervention groups.

Table 8: Reasons for not wearing spectacles

Variables	Group 1 n (%)	Group 2 n (%)	p-value
If you do not wear your spectacles as recommended, what are the reasons for that?	**n=23**	**n=15**	0.976
Do not like using them	6 (26.1%)	3 (20.0%)	
Spectacles cause headache	4 (17.4%)	1 (6.7%)	
No reason	4 (17.4%)	3 (20.0%)	
Do not feel the need to use them	2 (8.7%)	1 (6.7%)	
Concerned or teased about appearance with spectacles	2 (8.7%)	2 (13.3%)	
Other	2 (8.7%)	2 (13.3%)	
Do not feel comfortable wearing them	2 (8.7%)	2 (13.3%)	
Spectacles are broken or damaged	1 (4.3%)	1 (6.7%)	

Parental perspectives also highlighted the challenges related to spectacle use. While most parents stated that their children wore their spectacles (65.3% overall), a significant difference was observed between parents' views on their children's use of spectacles in Group 1 and Group 2, with 79.6% compliance and 54.4%, respectively (Table 8).

Table 9: Parental perspectives on spectacle use

Question	Group 1 n (%)	Group 2 n (%)	p-value
Does your child wear his/her spectacles?	**103 (43%)**	**136 (57%)**	**0.000**
No	21 (20.4%)	62 (45.6%)	
Yes	82 (79.6%)	74 (54.4%)	
Are you willing to pay for future spectacles?			**0.000**
No	30 (29.1%)	4 (2.9%)	
Yes	73 (70.9%)	132 (97.1%)	
If no, why not?			**0.011**
Price of spectacles	29 (96.7%)	2 (50.0%)	
Child will not wear them	0 (0.0%)	2 (50.0%)	
Other	1 (3.3%)	0 (0.0%)	

Regarding the willingness to pay for spectacles, 85.8% (205 parents) expressed a willingness to pay, with a significant difference between the groups: 70.9% in Group 1 and 97.1% in Group 2. For those not willing to pay, the primary reason cited was the price of spectacles, accounting for 91.2% of the responses (31 parents). This reason was almost universally reported in Group 1 (96.7%), but less so in Group 2 (50.0%). Additionally, 50.0% (two parents) in Group 2 indicated that they would not purchase spectacles because their child would not wear them, while no parents in Group 1 reported this reason.

Table 9 presents the observed agreement between parents' and children's responses regarding spectacle use. The question "Does your child wear his/her spectacles?" was assessed, revealing an overall agreement of 68.9% with a kappa value of 0.418, indicating fair agreement.

Table 10: Observed agreement and kappa test between parents and children's response to spectacle use

Questions	Compliance reported by parents		Agreement in % (Cohen's kappa)
Compliance reported by children	No	Yes	**68.9% (0.418)**
No	72 (86.7%)	61 (39.1%)	
Yes	11 (13.3%)	95 (60.9%)	

Quality of life (QoL) assessment

Descriptive system (Five dimensions)

Results presented here are based on the children for whom both baseline and endline data were available, 638 in total. At baseline, Figure 3 shows that the majority of children reported no problems with mobility (74.2%), self-care (92%), usual activities (70.3%) and feeling worried, sad or unhappy (76.0%). However, for the dimension “pain”, it was getting closer to parity, with 43.6% of the children reported having some, or a lot of, pain or discomfort (detailed results in Appendix S3). No statistical differences were observed between the comparator and the treatment groups regarding the level of problem for any of the five dimensions at baseline. At follow-up, both groups showed improvements across most dimensions. The comparator group exhibited a higher increase in mobility (“I have a lot of problems” decreasing from 7.4% to. 3.0%) and usual activities (“I have a lot of problems” decreasing from 8.0% to 7.6%), while the treatment group showed greater improvement in self-care (“I have a lot of problems” decreasing from 7.3% to 3.3%) and pain (“I have a lot of problems” decreasing from 8.3% to. 6.2%) (Figure 3). But again, for these four dimensions, no significant difference was observed between the comparator and treatment group. However, it is important to note that the worry dimension showed mixed results, with the comparator group improving (3.8% increase) and the treatment group experiencing a slight decrease (-1.7%), with a significant difference ($\chi 2$ p-value <0.05).

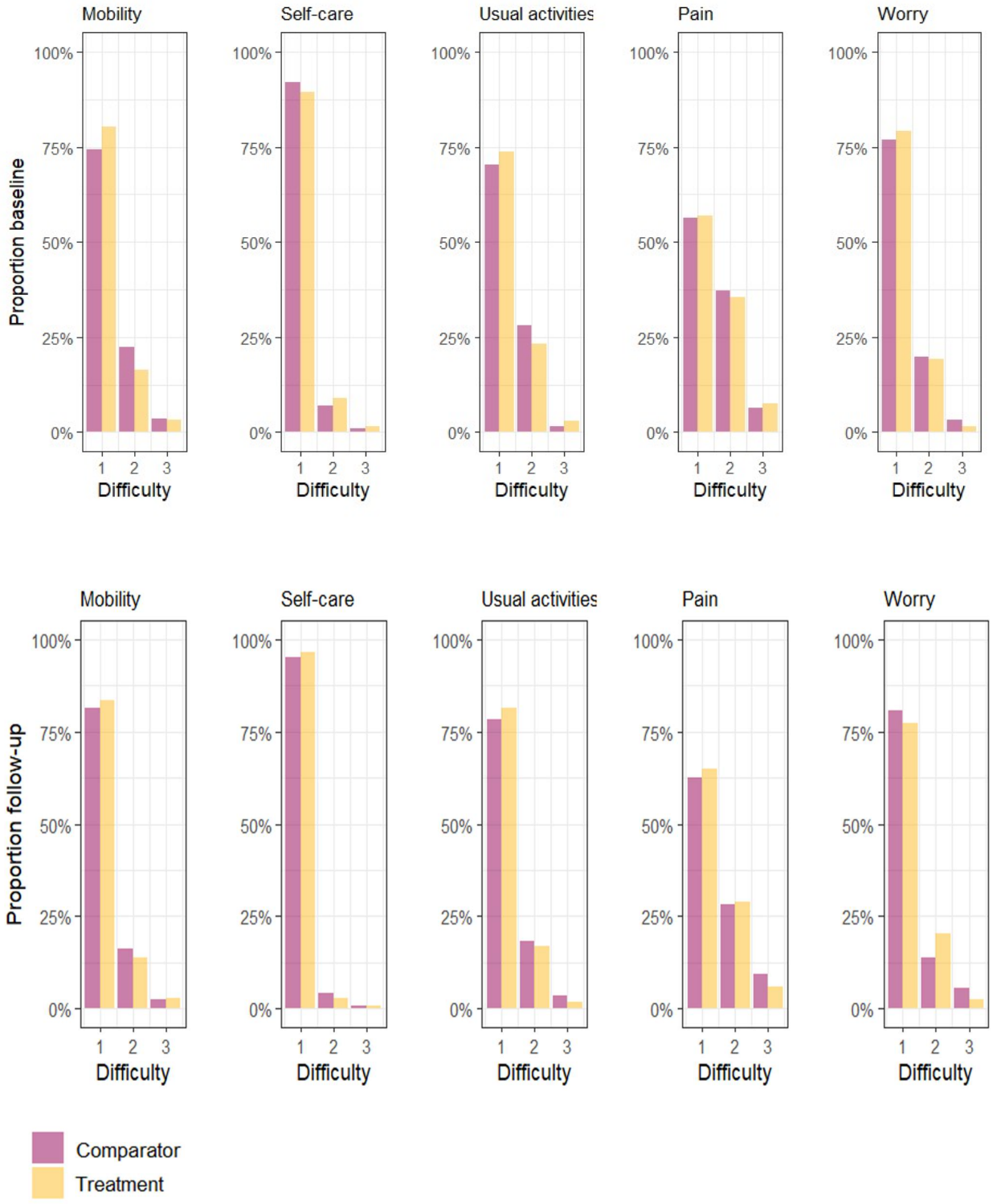


Figure 3: Quality of life at baseline and follow-up by dimension

Composite score (Five-dimension index combined with visual analogue scale score)

As discussed in the methodology, in the literature, girls' responses to QoL questionnaires were systematically lower scores than male respondents. Figure 4 shows that our sample (n=638) tends to confirm this. The red density area, representing girls, at baseline and follow-up show, on average, a lower QoL compared to boys (yellow density area).

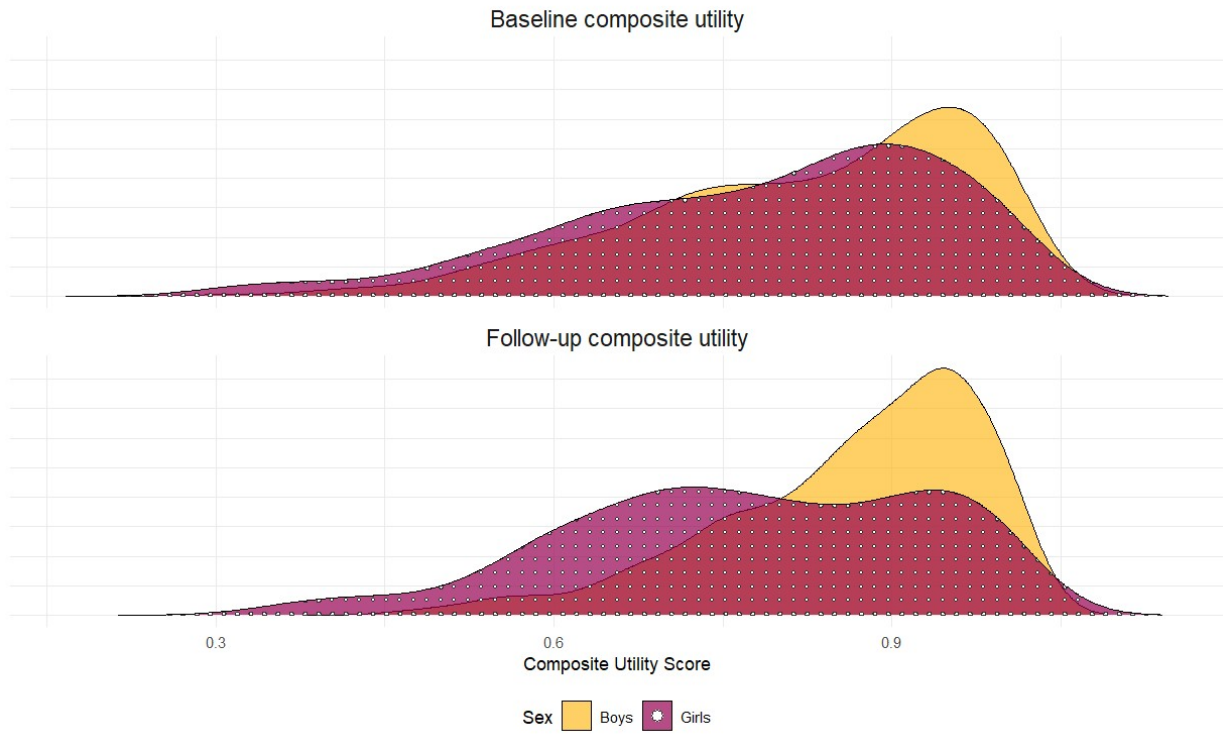


Figure 4: Baseline and follow-up composite quality of life index by sex (n=638)

Figure 5 depicts the EQ composite index results among schoolchildren of comparator and treatment groups where children complied and did not comply with their prescriptions. No significant difference in terms of QoL was observed between comparator and treatment groups at baseline or follow-up (details in Appendix S4). For the three groups, the mean composite score increased between baseline and follow-up data collection, but in different magnitude, namely by 0.019 score points (sd 0.2) for children in comparator groups, 0.003

score points (sd 0.179) for children identified with URE but who stated not wearing their spectacles, and 0.042 points (sd 0.176) for children with URE and who said they wore their spectacles.

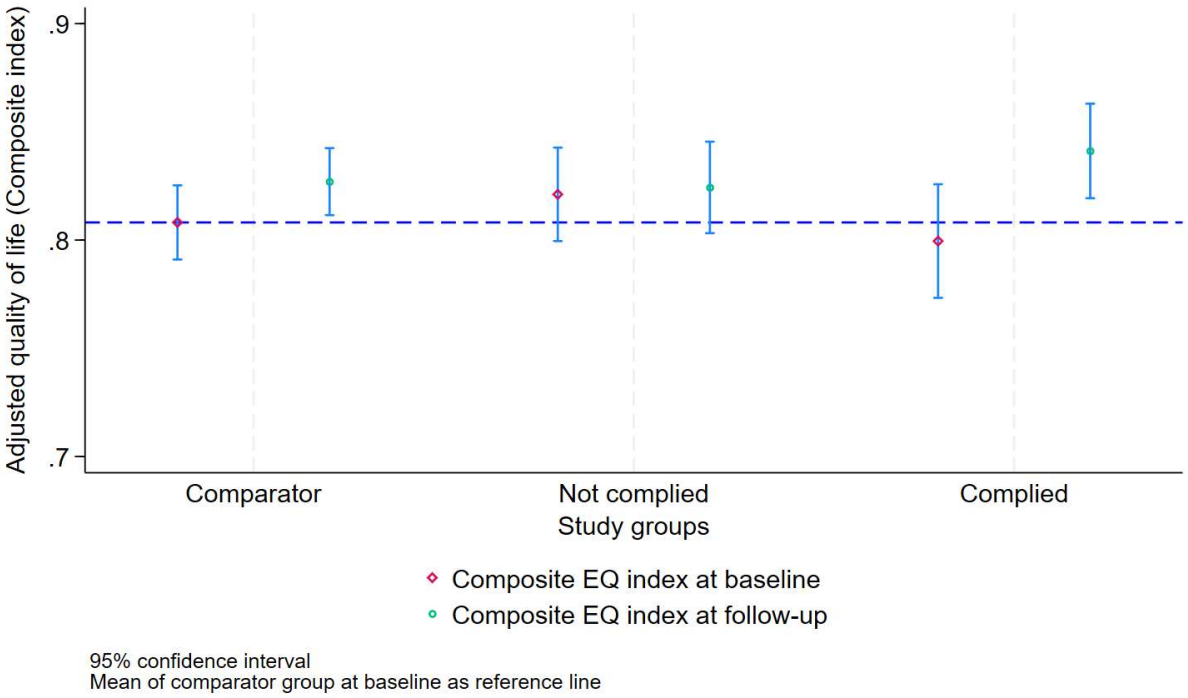


Figure 5: Composite ED index at baseline and follow-up by study group

A univariate analysis adjusted by sex and using the difference-in-difference approach has been conducted, to observe potential association with change in QoL scores between baseline and follow-up and between compliance and non-compliance groups. Several variables demonstrated significant associations with the outcome (QoL). Specifically, sex was found to have a negative coefficient of -0.043 (95% CI: -0.066 to -0.020, p=0.000), indicating that being a girl is associated with a lower change in QoL score (Table 11).

Similarly, age groups over 15 and grade groups 6 to 8 and over 10, showed a significant positive coefficient, respectively, of 0.042 (95% CI: 0.017 to 0.068, p=0.001) compared to the reference group of 10 to 15, and 0.069 (95% CI: 0.025 to 0.107, p=0.002) for grade 6 to 8 and 0.107 (95% CI: 0.065 to 0.148, p=0.000) for grades above the 10th compared to 1st to 5th graders. This suggests that "older" children and higher grades are associated with a higher increase in their EQ composite score. The school location, either urban or rural, approached significance with a coefficient of -0.027 (95% CI: -0.056 to 0.001, p=0.064), indicating that children in rural schools tend to have a lower change in their EQ-5D-Y-3L health score. Finally, compliance approached statistical significance 0.041 (95% CI: -0.004 to 0.087, p-value=0.075), suggesting a potential positive effect of the intervention over time on children's EQ-5D-Y-3l's health score.

When controlling for individually significant variables, the multivariate model showed that sex remained significantly associated with the change in EQ composite score, with a negative coefficient of -0.037 (95% CI: -0.066 to -0.008, p=0.013). The grade group also maintained its significant positive association (coefficient = 0.040, 95% CI: 0.015 to 0.066, p=0.002). However, school location lost its significance, whereas compliance approached significance in the multivariate model with a positive coefficient of 0.041 (95% CI: -0.003 to 0.086, p=0.070), suggesting a potential positive association when adjusting for other variables.

Table 11: Within intervention group results of sex-adjusted univariate and multivariate regression model of EQ composite score changes between baseline and follow-up (n=301)

	Univariate		Multivariate model	
Variables	**Coefficient [95% conf. interval]**	**P-values**	**95% conf. interval**	**P-values**
n (%)				
Sex (ref. boys)				
Girls	-0.043[-0.066 – -0.020]	**0.000****	-0.037[-0.066 – -0.008]	**0.013****
Age group (ref. age 10 to 15)				
>15	0.042 [0.017 – 0.068]	**0.001****	0.040[0.015 – 0.066]	**0.002****
Grade group (ref. grade 1 to 5)				
Grade 6 to 8	0.069 [0.025 – 0.107]	**0.002****		
Grade >10	0.107 [0.065 – 0.148]	**0.000****		
Location (ref. urban)				
Rural	-0.027 [-0.056 – 0.001]	**0.064***	-0.024[-0.053 – 0.005]	0.106
Compliance (ref. not complied)				
Complied	0.041 [-0.004 – 0.087]	**0.075***	0.041[-0.003 – 0.086]	**0.070***

*p-value <0.1
**p-value <0.05

Academic performance assessment

As stated in the methodology, academic results were missing for 339 children (53%), so the results for the remaining children were then only descriptively analysed (Figure 6).

The line plot shows that English test results for children that used their spectacles (green line) were systematically higher, starting at a higher point in October (sd 0.151) and finishing at an even higher score in January 2024 (sd 0.205), than children with URE but who did not wear their spectacles (yellow line) as advised (sd 0.021 in October 2023 and sd 0.116 in January 2024) (Appendix, S5 for details). Both groups, however, showed an improvement, whereas the comparator group (purple line) had a mean score lower in January 2024 (sd -0.029) than in October 2023 (sd 0.035).

As for the Maths test results, for all three groups the endline score in January 2024 was lower than the mean score in October 2023. However, we can observe a similar trend for children in comparator and in “not complied” group, following a decrease in November, then an increase in December, to finally see a sharper decrease for the children stating they were not using their spectacles in January 2024. However, for children who were wearing their spectacles, in spite of a slight decrease for the first two months, the January observation was positive, even though results did not reach the Maths mean score of October 2023.

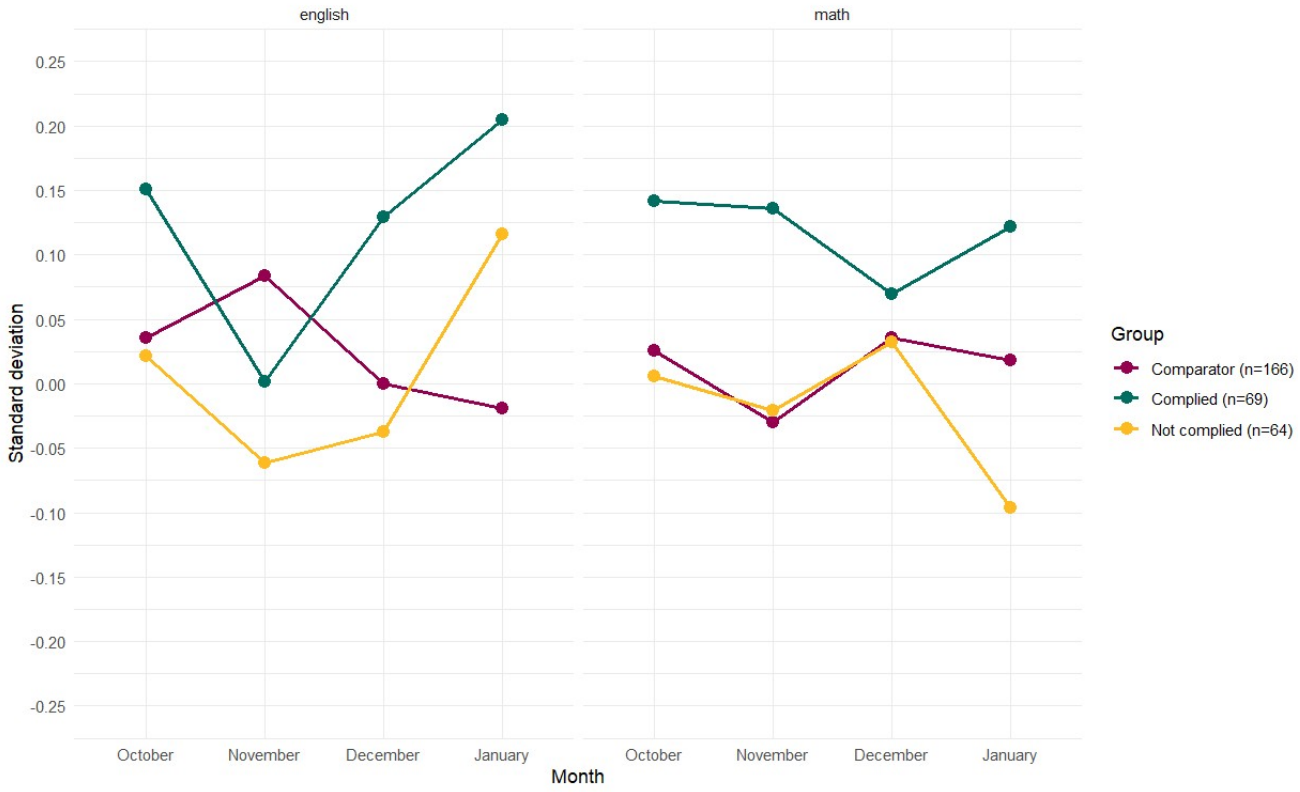


Figure 6: English and Maths mean results, standardised for each grade and school, by month and study groups (n=299)

Discussion

This study offers valuable insights into the factors influencing spectacle use and its impact on the QoL among schoolchildren in Pakistan. The findings suggest that providing free spectacles to children with UREs immediately after examination significantly increases their usage. Furthermore, when children use spectacles, their QoL, as assessed by the EQ-5D-3L-Y instrument, improves noticeably, and the incomplete academic performance sampled cautiously shows an improvement, especially in Maths.

The analysis showed that most children reported no problems with mobility, self-care, and usual activities. However, almost half of the children experienced pain or discomfort. The overall utility scores and visual analogue scale results showed slight improvements from baseline to follow-up for children with no visual impairment and a decrease for the treatment group, on average. Specifically, results for children in the treatment groups who received spectacles and used them as recommended, suggest greater improvements in QoL compared to the comparator group.

Indeed, the ownership and compliance in our study differed significantly depending on how the spectacles were provided. In Group 1, where children received a prescription and free spectacles, over 82% reported owning spectacles five to seven months after the provision, and nearly 54% had spectacles and wore them, as recommended. In contrast, in Group 2, where children received a prescription only, less than half (47%) reported owning spectacles, and just over a third (35%) had spectacles and wore them as recommended. For children who owned spectacles and used them as recommended or more often, compliance was 65.0% and 73.5% in Group 1 and Group 2, respectively.

In the multivariable analysis, the mode of the spectacle provision was the only factor significantly associated with spectacle ownership and compliance. In the group that received

spectacle prescriptions only, over 40% of children without spectacles said they could not obtain or afford them. Another 23% said they did not need spectacles; this percentage was higher than in Group 1 (18%). This could be related to the inability to obtain/afford spectacles, as it has been observed in health research that when people struggle financially to obtain a product, they downplay their needs, often to avoid feeling inadequate or stigmatised for being poor. The findings provide clear evidence that the provision of spectacles immediately after vision screening and free at the point of use increases both the effectiveness and efficiency of school health vision programmes. Similar results were found in the studies in Tanzania from Wedner et al and China from Ma et al. (11, 41).

If the determinants of compliance with spectacles are not entirely clear, children who wore their spectacles as recommended by the optometrist showed greater improvements in composite utility scores (0.042, 95% CI [0.013 - 0.070]) compared to non-compliant children, with 0.003 (95% CI [-0.020 - 0.029]) (Appendix S4). Despite the high variation and controlling for sex and grades (other significantly associated variables), the trend observed underscores the importance of ensuring that children not only receive spectacles to correct REs, but that they also use them consistently and as recommended (Table 9). In terms of comparison, an increase in the EQ-5D utility index of 0.04 falls within the 0.03 to 0.10 range of minimal important differences estimated by Coretti et al (42), or more recently Cheng et al at 0.04 for a baseline score-adjusted of 0.88 (43).

Academic improvement has also been measured for some children using their spectacles as recommended. Children in the “complied” group consistently demonstrated higher mean scores in Maths across all four months and in three months out of four in English (Figure 6). This suggests there might be a positive association between compliance with spectacle use and academic improvement compared to children with no visual impairment for both subjects and with children not wearing their spectacles in Maths. However, given that more than half of academic scores could not be retrieved, we can only describe our observation without

concluding a definite association. Further statistical analysis is required to determine the significance of these differences.

Overall, children's reported spectacle compliance for all schools participating in the study was 42.5%, which is lower than in the Brien Holden Vision Institute (BHVI) study (69%), but similar to Anwar's study (41%) (6, 29). Our findings show that the majority of children who had spectacles knew how to use them and wore them as prescribed. Around one in ten children in both groups could not remember how to use spectacles, which suggests that parents and teachers reminding children how to use spectacles is important. In Group 1, around 50% of children without spectacles said that their spectacles had been lost or broken. If we assume that all 125 children obtained spectacles after the screening, it means that around 9% of children lose or break them within five to seven months. The finding highlights the importance of increasing the availability of facilities where quality spectacles can be repaired or replaced, and improving the knowledge about these services among parents and teachers. Around 6% and 11% of children with spectacles in Group 1 and 2, respectively, said that the health provider had not told them how to wear spectacles. This finding shows how critical it is to ensure that optometrists providing spectacles explain how to wear them, both to children and their parents, along with highlighting the importance of correct spectacle use. It confirms what has been observed in various contexts by Dhirar et al or, more recently, by Wu et al (44, 45).

Parental perspectives also highlighted the challenges related to spectacle use. While most parents expressed a willingness to pay for future eye examinations and spectacles (85.8%), cost remained a significant barrier for some families (Table 8). This was highlighted by the ownership of spectacles comparison between Group 1, children who received spectacles directly after the examination, and Group 2 who received a prescription for spectacles at first, then spectacles after the trial period. Indeed, 82.4% of the children in Group 1 owned a pair, whereas only 47.2% of children in Group 2 owned a pair, despite receiving a prescription for

spectacles (Table 2). This suggests that interventions aimed at improving spectacle use should also address affordability and accessibility issues.

Parents need to be informed about the importance and cost of spectacles. Table 8 suggests that some parents – at least 31% or up to 94% – who were not willing to pay for spectacles, may have expectations about high cost, which could be addressed through awareness campaigns. Ensuring parents understand the value and affordability of spectacles can help increase their willingness to invest in their children's eye health.

The study's limitations include the relatively short follow-up period of five to seven months, which may not capture the long-term impact of spectacle use on QoL. The variation in utility scores and visual analogue scale may differ by the severity of visual impairment. However, 61 refraction results were missing; therefore, stratification by severity provided limited information. Additionally, enrolled schools were not selected using a random sampling technique, and all were drawn from a single region (ICT) in Pakistan due to programme implementation and time left in the SHIP project. For this reason, application to other populations must be made with caution. In addition, at the start of the study, monthly academic test scores in English and Maths were expected for six months. Unfortunately, test scores were only available for four months and for a limited number of children (46.8%). As a result, we only conducted a descriptive analysis, without drawing inferential statistical conclusions. Parents' information data was also incomplete; despite the sensitivity analysis showing no association with missing data, a complete data would have provided sturdier results.

Future research should consider longer follow-up periods to assess the sustained impact of spectacle use on QoL. Additionally, exploring interventions that address the barriers to compliance and affordability could enhance the effectiveness of school-based vision programmes.

In conclusion, the provision of spectacles to children with UREs suggests a positive impact on their QoL and academic performance. Ensuring compliance with spectacle use and addressing affordability issues are crucial for maximising the benefits of such interventions. These findings support the implementation of school-based vision programmes as a strategy to improve the vision and wellbeing of children with visual impairments.

Appendix

S1. Questionnaire

Baseline questionnaire

Background information

1. Did the parents consent to the quality of life and compliance survey?
    a) Yes
    b) No
1. Did the child assent to the quality of life and compliance survey?
    a) Yes
    b) No
2. Full name of the child
3. Name of the school
4. What grade is the child in?
5. Where do you live? (town, sector or village name)
6. Age of the child (in years)
7. Sex of the child
    a) Female
    b) Male
    c) Prefer not to say
8. Do you know your parents' or guardian's phone number?
9. After the screening, was the child prescribed with spectacles?
    a) Yes, spectacles prescription was given
    b) No spectacles

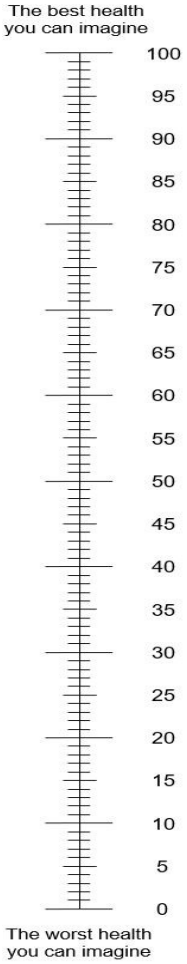
Quality of life instruments – EQ-5D-Y (Youth)

Under each heading, please tick the ONE box that you think best describes the child's health TODAY.

10. First, I would like to ask you about WALKING ABOUT (MOBILITY). Would you say that TODAY:
    a) No problems walking about
    b) Some problems walking about
    c) Have a lot of problems walking about
11. Next, I would like to ask you about LOOKING AFTER YOURSELF, today.
    a) No problems washing or dressing him/herself
    b) Some problems washing or dressing him/herself
    c) A lot of problems washing or dressing him/herself
12. Next, I would like to ask you about DOING USUAL ACTIVITIES, for example, going to school, hobbies, sports, playing, doing things with family or friends.

a) I have no problems doing my usual activities
b) I have some problems doing my usual activities
c) I have a lot of problems doing my usual activities

13. Next, I would like to ask you about HAVING PAIN OR DISCOMFORT, today:
    a) No pain or discomfort
    b) Some pain or discomfort
    c) A lot of pain or discomfort
14. Finally, I would like to ask you about FEELING WORRIED, SAD OR UNHAPPY, today:
    a) Not worried, sad or unhappy
    b) A bit worried, sad or unhappy
    c) Very worried, sad or unhappy
15. We would like to know how good or bad your health is TODAY. This line is numbered from 0 to 100. 100 means the best health you can imagine. 0 means the worst health you can imagine. Please mark a point on the line that shows how your health is TODAY



Children follow-up form

1. I am going to ask you few questions about how you feel today. Are you OK to continue?
    a) Yes
    b) No
2. Do you currently own a pair of spectacles?
    a) Yes
    b) No
3. If no, why not?
    a) Affordability
    b) Spectacles are broken or damaged or lost
    c) Parents disapprove of spectacles
    d) I don't think I need to wear spectacles
    e) Other
4. Please specify
5. Do you have them with you today?
    a) Yes
    b) No
6. If no, why don't you have your spectacles with you today?
    a) Spectacles are broken or damaged or lost
    b) Do not feel comfortable wearing them
    c) Cause headache
    d) Parents disapprove of spectacles
    e) Do not like using them
    f) I forgot them
    g) I don't like the design of the spectacles
    h) Other (please specify)
7. Please specify
8. Why?
9. When you had your eyes tested, how often were you told to wear your spectacles?
    a) All the time
    b) Only during school hours/when reading
    c) Occasionally/whenever I feel the need
    d) I don’t remember
    e) No one told me
10. Do you wear your spectacles as recommended?
    a) Yes
    b) No
11. How often do you wear spectacles?
    a) Constantly use spectacles
    b) Only use during school hours or when reading
    c) Occasionally/whenever I need to wear them
    d) I don't wear them
    e) Other (please specify)
12. Please specify
13. What are the reasons for not wearing your spectacles?
    a) Concerned or teased about appearance with spectacles
    b) Do not feel comfortable wearing them
    c) Do not like using them
    d) Do not feel the need to use them

e) Spectacles are broken or damaged
f) Spectacles are lost
g) Spectacles cause headache
h) Parents disapprove of spectacles
i) Other (please specify)

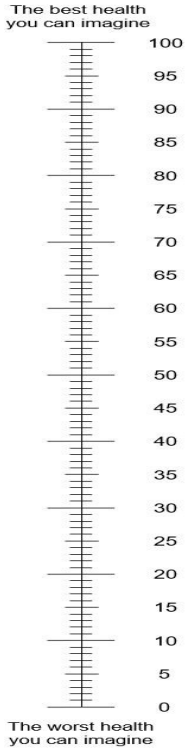
14. Please specify

Quality of life instruments – EQ-5D-Y (Youth)

Under each heading, please tick the ONE box that best describes the child's health TODAY

16. First, I would like to ask you about WALKING ABOUT (MOBILITY). Would you say that TODAY:
    d) No problems walking about
    e) Some problems walking about
    f) Have a lot of problems walking about
17. Next, I would like to ask you about LOOKING AFTER YOURSELF, today.
    d) No problems washing or dressing him/herself
    e) Some problems washing or dressing him/herself
    f) A lot of problems washing or dressing him/herself
18. Next, I would like to ask you about DOING USUAL ACTIVITIES, for example, going to school, hobbies, sports, playing, doing things with family or friends.
    d) I have no problems doing my usual activities
    e) I have some problems doing my usual activities
    f) I have a lot of problems doing my usual activities
19. Next, I would like to ask you about HAVING PAIN OR DISCOMFORT, today:
    d) No pain or discomfort
    e) Some pain or discomfort
    f) A lot of pain or discomfort
20. Finally, I would like to ask you about FEELING WORRIED, SAD OR UNHAPPY, today:
    d) Not worried, sad or unhappy
    e) A bit worried, sad or unhappy
    f) Very worried, sad or unhappy

21. We would like to know how good or bad your health is TODAY. This line is numbered from 0 to 100. 100 means the best health you can imagine. 0 means the worst health you can imagine. Please mark a point on the line that shows how your health is TODAY



Parents' follow-up form

1. Are you happy to answer a few questions on your family and on your child use of spectacles?
    a) Yes
    b) No
2. What is your relation to the child?
    a) Father
    b) Mother
    c) Legal guardian
3. What is the highest-level education of the child's father?
    a) Primary school (grade 1 to 5)
    b) Middle school (grade 6 to 8)
    c) Matriculation (grade 9 to 10)
    d) Intermediate (grade 11 to 12)
    e) Graduation (13 to 14)
    f) Masters (MA, MSc, MBA)
    g) No formal school
    h) Illiterate
    i) Not applicable

4. What is the highest-level education of the child's mother?
    a) Primary school (grade 1 to 5)
    b) Middle school (grade 6 to 8)
    c) Matriculation (grade 9 to 10)
    d) Intermediate (grade 11 to 12)
    e) Graduation (13 to 14)
    f) Masters (MA, MSc, MBA)
    g) No formal school
    h) Not applicable
    i) Illiterate
5. What is the highest-level education of the child's legal guardian?
    a) Primary school (grade 1 to 5)
    b) Middle school (grade 6 to 8)
    c) Matriculation (grade 9 to 10)
    d) Intermediate (grade 11 to 12)
    e) Graduation (13 to 14)
    f) Masters (MA, MSc, MBA)
    g) No formal school
    h) Illiterate
    i) Not applicable

6. What is the occupation of the father?
    a) Public employment
    b) Private employment (waged)
    c) Private employment (self-employment)
    d) None
    e) Can you specify?
7. What is the occupation of the mother?
    a) Government employee
    b) Private employment (waged)
    c) Private employment (self-employment)
    d) Homemaker/Housewife
    e) None
    f) Can you specify?
8. What is the occupation of the legal guardian?
    a) Government employee
    b) Private employment (waged)
    c) Private employment (self-employment)
    d) Homemaker/Housewife
    e) None
    f) Can you specify?

Spectacles use questionnaire (for parent or guardian)

9. Six months ago, your child received spectacles or a prescription for spectacles. Does your child currently have a pair of spectacles?
    a) Yes
    b) No
10. If yes, how often do they wear them?
    a) Constantly use spectacles
    b) Only use when he/she goes to school
    c) Occasionally whenever he/she needs to wear them
    d) He/she doesn't wear them
11. If your child only wears spectacles at school or occasionally, was this the recommendation from the optometrist?
    a) Yes
    b) No
    c) I don't know
12. Do you know the reasons for not wearing their spectacles?
    a) Concerned or teased about appearance with spectacles
    b) Does not feel comfortable wearing them
    c) Does not like using them
    d) Does not feel the need to use them
    e) Spectacles are broken or damaged
    f) Spectacles are lost
    g) Spectacles cause headache
    h) Parents disapprove of spectacles
    i) Other (please specify)
    j) Affordability
    k) Other (please specify)
13. If you disapprove of them, can you say why?
    a) I don't think my child needs them
    b) I don't like my child wearing spectacles
    c) Other (please specify)
14. Are you willing to pay for your child’s eye examination in future and purchase new spectacles when it is to change?
    a) Yes
    b) No
    c) Why not?
15. Affordability (price of spectacles)
    a) Do not see the use of spectacles
    b) Disapprove of spectacles
    c) Child will not wear them
    d) Other (please specify)

S2. Parents' education levels and occupations

	Intervention group 1	Intervention group 2	Total
N	100 (43.7%)	129 (56.3%)	229 (100.0%)
Father's education level			
No formal school	13 (13.0%)	14 (10.9%)	27 (11.8%)
Primary school	13 (13.0%)	20 (15.5%)	33 (14.4%)
Middle school	17 (17.0%)	10 (7.8%)	27 (11.8%)
Matriculation	29 (29.0%)	43 (33.3%)	72 (31.4%)
Intermediate	9 (9.0%)	24 (18.6%)	33 (14.4%)
Tertiary education	19 (19.0%)	18 (14.0%)	37 (16.2%)
Mother's education level			
No formal school	16 (16.0%)	27 (20.9%)	43 (18.8%)
Primary school	22 (22.0%)	24 (18.6%)	46 (20.1%)
Middle school	10 (10.0%)	20 (15.5%)	30 (13.1%)
Matriculation	30 (30.0%)	33 (25.6%)	63 (27.5%)
Intermediate	11 (11.0%)	17 (13.2%)	28 (12.2%)
Tertiary education	11 (11.0%)	8 (6.2%)	19 (8.3%)
Father's occupation			
None	10 (10.0%)	15 (11.6%)	25 (10.9%)
Clerical	50 (50.0%)	44 (34.1%)	94 (41.0%)
Private employment	20 (20.0%)	46 (35.7%)	66 (28.8%)
Professional/technical/managerial	20 (20.0%)	24 (18.6%)	44 (19.2%)
Mother's occupation			
None	10 (10.0%)	2 (1.6%)	12 (5.2%)
Homemaker	78 (78.0%)	113 (87.6%)	191 (83.4%)
Clerical	9 (9.0%)	7 (5.4%)	16 (7.0%)
Private employment	1 (1.0%)	3 (2.3%)	4 (1.7%)
Professional/technical/managerial	2 (2.0%)	4 (3.1%)	6 (2.6%)

S3. EQ-5D-3L-Y five dimensions results at baseline and follow-up

N	Control group 337 (52.8%)	Treatment group 301 (47.2%)	Total 638 (100.0%)
Baseline			
Mobility			
I have no problems	250 (74.2%)	242 (80.4%)	492 (77.1%)
I have some problems	75 (22.3%)	49 (16.3%)	124 (19.4%)
I have a lot of problems	12 (3.6%)	10 (3.3%)	22 (3.4%)
Self-care			
I have no problems	310 (92.0%)	269 (89.4%)	579 (90.8%)
I have some problems	24 (7.1%)	27 (9.0%)	51 (8.0%)
I have a lot of problems	3 (0.9%)	5 (1.7%)	8 (1.3%)
Usual activities			
I have no problems	237 (70.3%)	222 (73.8%)	459 (71.9%)
I have some problems	95 (28.2%)	70 (23.3%)	165 (25.9%)
I have a lot of problems	5 (1.5%)	9 (3.0%)	14 (2.2%)
Pain			
I have no pain or discomfort	190 (56.4%)	171 (56.8%)	361 (56.6%)
I have some pain or discomfort	125 (37.1%)	107 (35.5%)	232 (36.4%)
I have a lot of pain or discomfort	22 (6.5%)	23 (7.6%)	45 (7.1%)
Worry			
I am not worried, sad or unhappy	259 (76.9%)	238 (79.1%)	497 (77.9%)
I am a bit worried, sad or unhappy	67 (19.9%)	58 (19.3%)	125 (19.6%)
I am very worried, sad or unhappy	11 (3.3%)	5 (1.7%)	16 (2.5%)
Follow-up			
Mobility			
I have no problems	275 (81.6%)	251 (83.4%)	526 (82.4%)
I have some problems	54 (16.0%)	42 (14.0%)	96 (15.0%)
I have a lot of problems	8 (2.4%)	8 (2.7%)	16 (2.5%)
Self-care			
I have no problems	321 (95.3%)	291 (96.7%)	612 (95.9%)
I have some problems	14 (4.2%)	8 (2.7%)	22 (3.4%)
I have a lot of problems	2 (0.6%)	2 (0.7%)	4 (0.6%)
Usual activities			
I have no problems	264 (78.3%)	245 (81.4%)	509 (79.8%)
I have some problems	61 (18.1%)	51 (16.9%)	112 (17.6%)
I have a lot of problems	12 (3.6%)	5 (1.7%)	17 (2.7%)
Pain			
I have no pain or discomfort	211 (62.6%)	196 (65.1%)	407 (63.8%)
I have some pain or discomfort	95 (28.2%)	87 (28.9%)	182 (28.5%)
I have a lot of pain or discomfort	31 (9.2%)	18 (6.0%)	49 (7.7%)
Worry*			
I am not worried, sad or unhappy	272 (80.7%)	233 (77.4%)	505 (79.2%)
I am a bit worried, sad or unhappy	46 (13.6%)	61 (20.3%)	107 (16.8%)
I am very worried, sad or unhappy	19 (5.6%)	7 (2.3%)	26 (4.1%)

*X^2 test of association, p-value <0.05

S4. EQ composite index scores at baseline and follow-up for comparator and treatment group n(SD) and [95% conf. interval]

	Comparator	No compliance	Complied	Total
N	**337 (52.8%)**	**167 (55.5%)**	**134 (44.5%)**	**638 (100.0%)**
Mean score at baseline	0.808 (0.160) [0.791 - 0.825]	0.821 (0.141) [0.780 - 0.842]	0.800 (0.154) [0.773 - 0.825]	0.810 (0.154)
Mean score at follow-up	0.827 (0.144) [0.811 - 0.842]	0.824 (0.138) [0.803 - 0.845]	0.841 (0.128) [0.819 - 0.863]	0.829 (0.139)
Change of mean score	0.019 (0.173) [0.003 - 0.036]	0.003 (0.179) [0.020 - 0.029]	0.042 (0.181) [0.013 - 0.070]	0.020 (0.176)

S5. English and Maths test results standardised for each grade and school, by month

	Study groups		
	Comparator	**Not complied**	**Complied**
N	166 (55.5%)	64 (21.4%)	69 (23.1%)
Mean value Maths (23 October)	0.026 (0.938)	0.006 (0.959)	0.141 (0.923)
Mean value English (23 October)	0.035 (0.957)	0.021 (0.927)	0.151 (0.924)
Mean value Maths (23 November)	-0.030 (0.909)	-0.021 (0.922)	0.136 (0.977)
Mean value English (23 November)	0.084 (0.906)	-0.061 (0.974)	0.001 (1.009)
Mean value Math (23 December)	0.036 (0.941)	0.033 (0.952)	0.070 (1.044)
Mean value English (23 December)	0.000 (0.979)	-0.038 (0.900)	0.130 (0.948)
Mean value Math (23 January)	0.018 (0.922)	-0.096 (0.938)	0.121 (0.857)
Mean value English (23 January)	-0.019 (0.950)	0.116 (0.920)	0.205 (0.920)

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