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Demographic characteristics and ocular needs of children attending child eye clinics in Cross River State, Nigeria: a retrospective analysis of clinical records

Ai Chee Yong,[1] Anne Effiom Ebri,[1] Sara E O'Connor,[2] Diarmuid O'Donovan,[1] Nathan Congdon,[1,3] Christine Graham,[4] Lynne Lohfeld,[1,5] Ciaran O'Neill,[1] Ving Fai Chan [1,6]

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For numbered affiliations see end of article.

Correspondence to
Dr Ving Fai Chan;
v.chan@qub.ac.uk

ABSTRACT

Objectives To describe the demographic characteristics and ocular needs of children attending four child eye clinics in Cross River State, Nigeria, to inform the development of a sustainable spectacle cross-subsidisation scheme.

Design Retrospective analysis of clinic records.

Setting Four child eye clinics in Calabar, Ogoja, Ikom and Ugep, Cross River State, Nigeria, from 1 May 2017 to 30 June 2019.

Participants Children who failed the vision screening in schools and visited assigned child eye clinics, and self-referred children from the community.

Main outcome measures Children's age, sex, residence, diagnosis, disease management, presenting and corrected visual acuity, history of spectacle wear and magnitude of refractive errors in spherical equivalent in the worse eye.

Results Of all the 3799 records reviewed, data were available for 3774 children (mean age 10.6±4.35 years; 61.6% girls; 69.1% from urban settings); 30.8% (n=1162) of them had vision impairment. Of those children, 71.2% (n=827) were diagnosed with refractive error. For management, 48.6% (n=1833) were prescribed spectacles and 40.5% (n=1527) were prescribed ocular medications. Children prescribed spectacles were significantly more likely to be girls (68.0%, p<0.001), and older than 13 years of age (53.6%, p<0.001). The most common range of spherical equivalent (in the worse eye) was <−0.50 DS to +1.75 DS (51.6%, n=945), followed by >−0.25 DS to −3.00DS (39.7%, n=727). Non-refractive eye conditions such as cataract (33.3%) and corneal disorders (14.1%) contributed to almost half of the total blindness.

Conclusion The findings show that spectacles provisions and ocular medications are the primary and secondary needs for children who attended child eye clinics seeking eye care services. Further research is needed to understand parents' willingness to pay for spectacles to set strategic multitier pricing for a sustainable cross-subsidisation scheme.

Strengths and limitations of this study

- ⇒ Including a large sample consisting of children from four different child clinics in Cross River State provides a representative description of the population.
- ⇒ Children who failed vision screening at school and then failed to attend referral visits were not represented.
- ⇒ Children living in rural areas or whose guardians have limited literacy regarding the importance of healthy vision were not captured in the analysis.
- ⇒ Data on best-corrected visual acuity in children prescribed spectacles were not available.
- ⇒ No follow-up data on children who were referred for specialist care were available.

INTRODUCTION

In Nigeria, refractive error affects 5%–8% of children aged 5–17 years, and remains the leading cause of vision impairment in schoolchildren.[1 2] A key reason is the lack of accessibility and expense of spectacle correction.[3] To address the burden of avoidable vision impairment among Nigerian schoolchildren, a 2-year Seeing is Believing collaborative programme, Comprehensive Child Eye Health in Nigeria (CCEHiN), was launched in May 2017. Among the participating states was Cross River State, where children were screened at school, and those who failed the screening were referred to one of the four child eye clinics in the state (Calabar, Ugep, Ikom or Ogoja). Children with uncorrected refractive errors were given free spectacles, and those with eye and/or eyelid infections were prescribed medications.

As a continuation of the CCEHiN programme, the Cross River State government is considering establishing a spectacles cross-subsidisation scheme to increase access to spectacles for all children in need in a sustainable way. The proposal is that we aim to increase access to spectacles for all children (affluent, urban-poor and rural-poor) by cross-subsidising the provision of

Table 1 Shows the spectacle types, description, proposed pricing and profit and loss margins from the spectacle sales

Spectacle type	Description	Proposed pricing	Profit/loss margin
Standard	Limited selection of frames and normal plastic lenses	₦2500	25% loss
Mid-premium	Upgraded frames and normal plastic lenses	₦3600	50% profit
High premium	Upgraded frames and upgraded lenses	₦4400	50% profit

inexpensive standard spectacles to children whose families cannot afford them using the revenue generated from selling mid and high-premium spectacles. This will be done through a tiered pricing structure of ₦2500 (low), ₦3600 (mid) and ₦4400 (high). Table 1 shows the spectacle types, description, proposed and profit and loss margins from the spectacle sales. It is important to identify and understand the target users' demographic characteristics and ocular needs to ensure the development of an appropriate and sustainable scheme.

Our previous work, which looked at user behavioural profiles, found that spectacle frame design, material and quality are key factors influencing guardians when purchasing spectacles for their children.[4] We further determined a need to correct misperceptions among parents regarding their children's vision and ocular conditions to increase the demand for child eye care services.[5]

This article focuses on understanding the clinics' current patients to inform the development of a sustainable spectacles cross-subsidisation scheme. Describing patient demographic characteristics, their ocular needs, diagnoses, types of management given and characteristics of children prescribed spectacles can be used to develop an evidence-based targeted strategy to ensure that the services provided meet the needs of the children.

METHODS

Patient and public involvement

Patients or the public were not involved in the design or conduct of our research. However, the public was invited to attend the dissemination event to provide their feedback.

Study design

A retrospective analysis of clinical records of the four child eye clinics was conducted.

Comprehensive eye examination in the child eye clinics

Referred children who attended the four child eye clinics were examined comprehensively by qualified optometrists who work closely with ophthalmologists. All children underwent examinations that included presenting visual acuity testing using a LogMAR chart at 6 m (or an LEA grating chart for infants and children with learning disabilities), objective and subjective refraction, and anterior and posterior eye segment examination. Cycloplegic refraction was not routinely performed except for children with hyperopia or complicated conditions such as cataract and retinal abnormalities. One drop of 1% cyclopentolate followed by one drop of 0.5% tropicamide was instilled 5 min apart and refraction was done after 30 min. Retinoscopy was performed, and the optometrists refined the final prescription by subjective refraction. After the detailed assessment, the diagnosis of each child was determined and recorded. When there were doubts about the diagnosis and treatment, a resident ophthalmologist was consulted.

Medications (eye-drops) were prescribed for children with conjunctival or eyelid infections. At the same time, a complimenatary pair of spectacles was dispensed to children who had correctable presenting vision of <6/12 or those who had ≥6/12 but with symptomatic complaints such as headache and glare. Custom-made spectacles were dispensed to the child within 1 week after the eye examination.

Data extraction

Two data extractors underwent a 2-day training programme to familiarise themselves with the data extraction process and ensure standardisation. They then reviewed the patient records and extracted the relevant data onto a data recording sheet that had been pilot tested and amended prior to use. The data extracted were the children's age, sex, residence location, presenting and corrected visual acuity, history of spectacle wear, types of eye morbidities, disease management, and the magnitude of refractive errors in spherical equivalent (SE) in the worse eye. For children with multiple eye conditions, the diagnosis made is based on the condition which requires immediate treatment. For example, a child would be considered to have a conjunctival disorder and not refractive error if he/she presented with both allergic conjunctivitis and uncorrected refractive error.

Data management and analysis

Statistical Package for Social Science V.25.0 (SPSS) was used for data management and analysis. The data were cleaned and checked for inconsistencies. Children's demographic profiles included age (≤5 years old, 6–12 years old and ≥13 years old), sex (male or female), residence locations based on their addresses (rural or urban) and whether they wore spectacles prior to their visits (yes or no). Only those aged 17 years and below were included in the analysis following the WHO's definition of children's age.[6] Presenting visual acuity in Log of Minimum Angle of Resolution (LogMAR) was converted to Snellen format: LogMAR 0.3 was equivalent to Snellen 6/12; LogMAR 1.3 was equivalent to Snellen 3/60. Subsequently, they were categorised into 'no vision impairment' (≥6/12 in

Table 2 Children's sociodemographic characteristics (n=3774)

	Clinics					
	Calabar, n (%)	Ugep, n (%)	Ikom, n (%)	Ogoja, n (%)	Total n (%)	P value comparing demographic variables among the four clinics
Sex						<0.001*
Girls	999 (58.7)	484 (72.2)	368 (62.0)	473 (58.6)	2324 (61.6)	
Boys	703 (41.3)	186 (27.8)	227 (38.0)	334 (41.4)	1449 (38.4)	
Age groups						<0.001*
≤5 years old	290 (17.0)	21 (3.10)	188 (31.6)	107 (13.3)	606 (16.1)	
six to 12 years old	736 (43.2)	292 (43.6)	200 (33.7)	361 (44.7)	1589 (42.1)	
≥13 years old	676 (39.7)	357 (53.3)	207 (34.7)	339 (42.0)	1578 (41.8)	
Mean age±SD (years)	10.4±4.31	12.2±2.74	9.02±5.38	10.9±4.15	10.6±4.35	<0.001†
Residence location						<0.001*
Rural	783 (46.0)	160 (23.9)	77 (13.0)	145 (18.0)	1165 (30.9)	
Urban	919 (54.0)	510 (76.1)	518 (87.0)	662 (82.0)	2608 (69.1)	
History of wearing spectacles						<0.001*
No	1615 (94.9)	668 (99.7)	563 (94.8)	797 (98.8)	3643 (96.6)	
Yes	87 (5.10)	2 (0.30)	32 (5.20)	10 (1.20)	130 (3.40)	
Total	1702 (100)	670 (100)	595 (100)	807 (100)	3774 (100)	

*χ^2 was used, significant level at 5%.
†ANOVA was used.
ANOVA, analysis of variance.

the worse eye), 'moderate vision impairment' (<6/12 to 3/60 in the worse eye), and 'blind' (<3/60 in the worse eye). Because we aimed to determine the proportion of children who needed eye care services in the eye clinics, presenting vision in the worse eye was collected instead of in the better eye. SE was calculated by adding half of the cylindrical power into spherical power. Ranges of SE were categorised into six groups: >−6.00 DS, >−3.00 DS to −6.00DS, −0.25DS to −3.00DS, <−0.50 DS to +1.75 DS, >+1.75 DS to +5.00 DS and >+5.00 DS. Some records also contained visual acuity measurement using LEA gratings in very young children and were grouped into 8.0 cycles per centimetre (cpcm), 4.0 cpcm and equal to or less than 3.0 cpcm. Prevalence of the most reported eye conditions and the demographic and clinical characteristics of children prescribed spectacles are described.

RESULTS

The records of 3799 children who visited the child eye clinics from 1 May 2017 to 30 June 2019 in Calabar, Ugep, Ikom and Ogoja were reviewed. Complete data were available for 3774 children. The demographic characteristics of the children are summarised in table 2. The mean age of children was 10.6±4.35 years of age, with ages ranging from <1 to 17 years of age. Of all participants, 83.9% were 6 years old or above. Most (61.6%) of the children were girls, 69.1% were from urban settings and only 3.40% wore spectacles on presentation.

The children's vision status and diagnosis are summarised in table 3. Of the children whose vision were recorded using Snellen's format, 31.9% (n=1120) had either mild or moderate-to-severe vision impairment in the worse eye. In this group, refractive error (73.8%, n=827) was the most reported eye condition, followed by cataract (6.58%, n=74), conjunctival disorders (5.69%, n=64) and corneal disorders (4.18%, n=47). In the cohort of children whose vision status was measured with the LEA chart, conjunctival disorders (82.0%, n=219) were the most common diagnosis.

Table 4 summarises treatments provided to the children by the four child eye clinics. From the 3774 children included in the complete dataset, 1833 children (48.6%) needed spectacle correction. This included children with vision impairment (presenting visual acuity <6/12 in the worse eye) or children not classified as having vision impairment but for whom refractive correction was deemed necessary by the optometrists. The proportion was similar in three of the four clinics (range 42.4%–56.2%); however, at the Ikom clinic, only 27.7% of children needed a spectacle prescription. Eye medications for infectious and non-infectious conjunctivitis were prescribed for 40.5% of all children, a proportion similar in all four clinics. A total of 122 children (3.21%) were referred to a hospital for specialist management of more complex conditions, including cataract, ocular injury, corneal opacity and others.

Table 5 presents the demographic characteristics of children who were prescribed spectacles. Among them, there were significantly more girls than boys (68.0%, p<0.001) and more older than younger children (53.6%,

Table 3 Children's vision status and diagnosis (n=3773)

	Visual acuity in Snellen in the worse eye				Visual acuity in LEA grating in the worse eye			
	No vision impairment	Vision impairment						
	≥6/12	<6/12 to 3/60	<3/60	Total	8.0cpcm	4.0cpcm	≤3.0cpcm	Total
Amblyopia	0 (0.0%)	5 (0.5%)	0 (0.0%)	5 (0.1%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Cataract	2 (0.1%)	15 (1.6%)	59 (33.3%)	76 (2.2%)	3 (1.3%)	3 (12%)	1 (5.9%)	7 (2.6%)
Conjunctival disorders	991 (41.5%)	59 (6.2%)	5 (2.8%)	1055 (30.1%)	196 (87.1%)	16 (64%)	7 (41.2%)	219 (82.0%)
Corneal disorders	12 (0.5%)	22 (2.3%)	25 (14.1%)	59 (1.7%)	1 (0.4%)	3 (12%)	1 (5.9%)	5 (1.9%)
Eyelid disorders	28 (1.2%)	8 (0.8%)	0 (0.0%)	36 (1.0%)	3 (1.3%)	1 (4.0%)	0 (0.0%)	4 (1.5%)
Glaucoma	13 (0.5%)	4 (0.4%)	2 (1.1%)	19 (0.5%)	0 (0.0%)	0 (0.0%)	2 (11.8%)	2 (0.7%)
Lacrimal duct disorders	10 (0.4%)	0 (0.0%)	0 (0.0%)	10 (0.3%)	5 (2.0%)	0 (0.0%)	0 (0.0%)	5 (1.9%)
Macular disorders	0 (0.0%)	3 (0.3%)	5 (2.8%)	8 (0.2%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Nystagmus	1 (0.0%)	2 (0.2%)	0 (0.0%)	3 (0.1%)	0 (0.0%)	0 (0.0%)	2 (11.8%)	2 (0.7%)
Ocular cancer	1 (0.0%)	1 (0.1%)	3 (1.7%(	5 (0.1%)	0 (0.0%)	0 (0.0%)	2 (11.8%)	2 (0.7%)
Ocular injury	34 (1.4%)	11 (1.2%)	15 (8.5%)	60 (1.7%)	2 (0.9%)	0 (0.0%)	0 (0.0%)	2 (0.7%)
Optic nerve disorders	0 (0.0%)	0 (0.0%)	3 (1.7%)	3 (0.1%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Refractive error	1038 (43.5%)	791 (83.9%)	36 (20.3%)	1865 (53.2%)	2 (0.9%)	0 (0.0%)	0 (0.0%)	2 (0.7%)
Retinal disorders	0 (0.0%)	3 (0.3%)	7 (4.0%)	10 (0.3%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Routine check	228 (9.6%)	3 (0.3%)	0 (0.0%)	231 (6.6%)	10 (3.9%)	1 (4.0%)	1 (5.9%)	12 (4.5%)
Sclera disorders	5 (0.2%)	0 (0.0%)	0 (0.0%)	5 (0.1%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Strabismus	4 (0.2%)	3 (0.3%)	1 (0.6%)	8 (0.2%)	1 (0.4%)	1 (4.0%)	1 (5.9%)	3 (1.1%)
Uveitis	18 (0.7%)	8 (0.8%)	5 (2.8%)	31 (0.9%)	2 (0.9%)	0 (0.0%)	0 (0.0%)	2 (0.7%)
Others	1 (0.0%)	5 (0.5%)	11 (6.2%)	17 (0.5%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Total	2386 (100%)	943 (100%)	177 (100%)	3506 (100%)	225 (100%)	25 (100%)	17 (100%)	267 (100%)

Missing data, n=1.
Snellen 6/12 equals to Log of Minimum Angle of Resolution (LogMAR) 0.3; Snellen 3/60 equals to LogMAR 1.3; cpcm=cycles per 1 cm (refer to online supplemental file for ocular disorders categorisation).

Table 4 Types of management in the four public child eye clinics (n=3774)

Types of management	Clinics				Total n (%)
	Calabar, n (%)	Ugep, n (%)	Ikom, n (%)	Ogoja, n (%)	
Counselling	39 (2.29)	38 (5.67)	0 (0.0)	0 (0.0)	77 (2.03)
Foreign body removal	1 (0.06)	0 (0.0)	1 (0.17)	1 (0.12)	3 (0.08)
Low vision rehabilitation/devices	3 (0.18)	0 (0.0)	2 (0.34)	1 (0.12)	6 (0.16)
Medications	617 (36.3)	261 (39.0)	259 (43.6)	390 (48.3)	1527 (40.5)
Referred for further action*	84 (4.93)	2 (0.30)	16 (2.69)	20 (2.48)	122 (3.21)
Spectacles	957 (56.2)	369 (55.1)	165 (27.7)	342 (42.4)	1833 (48.6)
Warm compression	0 (0.0)	0 (0.0)	2 (0.34)	1 (0.1)	3 (0.08)
None†	1 (0.06)	0 (0.0)	150 (25.2)	52 (6.44)	203 (5.40)
Total	1702 (100)	670 (100)	595 (100)	807 (100)	3774 (100)

*Eye conditions such as cataract, ocular injury, nystagmus, ocular cancer, retinal disorders, etc.
†Routine follow-up children with no further management.

p<0.001). More than half of the children (51.6%, n=945) had SE of <–0.50 DS to +1.75 DS, and 39.7% (n=727) had >–0.25 DS to –3.00DS. Of the children prescribed spectacles at the time of their clinic visit, only 6.30% had a history of wearing spectacles.

Table 5 Children's characteristics who were prescribed spectacles (n=1833)

	Clinics					P value comparing demographic variables among the four clinics*	P value comparing demographic variables and status of prescribing spectacles*
	Calabar, n (%)	Ugep, n (%)	Ikom, n (%)	Ogoja, n (%)	Total n (%)		
Sex						0.045	<0.001
Girls	654 (68.3)	266 (72.1)	113 (68.5)	213 (62.3)	1246 (68.0)		
Boys	303 (31.7)	103 (27.9)	52 (31.5)	129 (37.7)	587 (32.0)		
Age group						<0.001	<0.001
≤5 years old	45 (4.70)	0 (0.00)	4 (2.40)	8 (2.30)	57 (3.10)		
6–12 years old	421 (44.0)	143 (38.8)	68 (41.2)	162 (47.4)	794 (43.3)		
≥13 years old	491 (51.3)	226 (61.2)	93 (56.4)	172 (50.3)	982 (53.6)		
Children's location						<0.001	0.204
Rural	432 (45.1)	83 (22.5)	19 (11.5)	50 (14.6)	584 (31.9)		
Urban	525 (54.9)	286 (77.5)	146 (88.5)	292 (85.4)	1249 (68.1)		
History of wearing spectacles						<0.001	<0.001
No	878 (91.7)	368 (99.7)	139 (84.2)	332 (97.1)	1717 (93.7)		
Yes	79 (8.30)	1 (0.30)	26 (15.8)	10 (2.90)	116 (6.30)		
Spherical equivalent†						<0.001	<0.001
>–6.00DS	19 (2.00)	2 (0.54)	1 (0.60)	5 (1.45)	27 (1.46)		
>–3.00 DS to –6.00DS	71 (7.40)	6 (1.61)	6 (3.59)	13 (3.76)	96 (5.20)		
>–0.25 DS to –3.00DS	285 (29.8)	300 (81.3)	80 (48.5)	62 (18.1)	727 (39.7)		
<–0.50 DS to+1.75DS	565 (59.0)	59 (15.9)	72 (43.1)	249 (72.8)	945 (51.6)		
>+1.75 DS to+5.00DS	14 (1.50)	1 (0.30)	4 (2.40)	12 (3.50)	31 (1.73)		
>+5.00DS	3 (0.30)	1 (0.30)	2 (1.20)	1 (0.29)	7 (0.38)		
Total	957 (100)	369 (100)	165 (100)	342 (100)	1833 (100)		

*χ^2 test was used, significant level at 5%.
†Spherical equivalent was calculated by adding half of the cylindrical power to the spherical power.

DISCUSSION

This study maps the demographic characteristics and ocular profiles of children who attended four child eye clinics in Cross River State, Nigeria. Most children receiving eye care services had refractive error (SE ranged from <−3.00 DS to +1.75 DS) and/or conjunctival disorders. Spectacles and eye medications were the most frequently used treatments. Children prescribed spectacles were more likely to be girls, living in an urban setting and 6 years of age or older. This study highlighted the potential for a spectacle cross-subsidisation scheme for children in Nigeria and further provided information to plan for the scheme.

Nearly one in two school-aged children in this study visited an eye clinic due to uncorrected refractive error. These children presented to the clinics because they had symptomatic reduced vision or had failed a recent school vision screening. With this high optical correction prescribing rate, measures are planned to address barriers to uptake. In light of other studies showing a high burden of refractive error,[6–9] we predict that there is adequate demand to support a cross-subsidisation scheme.[10] Such a programme could reduce the overall burden of preventable childhood vision impairment by improving access to effective yet low-cost spectacles.

Although this study aimed to inform essential aspects of a spectacles cross-subsidisation scheme, we also found that non-visually impairing ocular conditions were prevalent. Of all the children who sought eye health services from the four clinics, 39.0% did not have visual complaints but instead suffered from conjunctival disorders such as conjunctivitis and eyelid disorders (eg, stye and chalazion). This finding echoes those of Rono *et al* who reported that over half of the presentations (61.0%) in one of Kenya's secondary eye health facilities was for allergic conjunctivitis or other conjunctival conditions, rather than visual complaints per se.[11] This suggests that ocular conditions that have no impact on vision yet potentially affect a person's quality of life are very common and need to be addressed. As highlighted in the Lancet Global Health Commission on Global Eye Health: Vision Beyond 2020, data are needed to inform healthcare planning regarding the relative burden of non-visual conditions and the extent to which they will increase estimates for service capacity based solely on the prevalence of vision impairment.[12]

This study also found that among children who were prescribed spectacles, only 6.40% owned a pair of spectacles previously. This low number of spectacle wearers is possibly due to a combination of factors, including a shortage of local eye care practitioners, the lack of eye health infrastructure, a lack of appreciation for the importance of spectacle correction by parents or guardians, and the cost of new spectacles.[13 14] Ekpenyong *et al* found that in a school-based vision screening programme in southern Nigeria, nearly 90.0% of children (6–17 years old) had never had an eye examination.[15] A comprehensive vision screening programme to identify refractive errors, in conjunction with a cross-subsidisation scheme, would be needed to maximise the benefit of a cross-subsidisation scheme[10 16] and address overall eye health needs.

More girls than boys were prescribed spectacles in our cohort, which might be due to a higher prevalence of refractive errors in this population. Ajaiyeoba *et al*'s population-based study in Nigeria[17] found that refractive error was almost twice as common in girls as in boys. Our earlier study[4] found that parents prioritised frame design, material and quality when purchasing spectacles for their children. Taken together, these findings indicate that planning for spectacle inventory should consider the gender balance of refractive error and what parents consider attractive and appropriate for daughters as well as sons.

The current study found that most children (91.2%) had a refractive error between +1.75 DS and −3.00 DS. This indicates that stock lenses stored on-site in child eye clinics can cover the very large majority of prescription needs, allowing for same-day cut-and-fit services in collaboration with a local dispensing laboratory. In addition, spectacles made using stock lenses are about four to five times cheaper than custom-made spectacles.[18 19] Same-day cut-and-fit services can also reduce the logistical cost of fitting spectacles and ease the burden on families by eliminating the need to visit the clinic again to collect the spectacles. The Calabar Child Eye Health Clinic and the Opticianry College have already started to explore such a collaboration.

Apart from uncorrected refractive error and conjunctival disorders, there is also a need to address conditions such as cataract and corneal disorders in children. Therefore, a collaborative partnership with paediatric ophthalmologists in nearby tertiary hospitals must be built so those children who require their services can be referred to and managed well in future child eye health screening programmes. In the future, if the scheme proves to be viable we propose replicating such scheme to cover other eye treatments such as cataract surgery for the underprivileged population.

The strengths of this study include the large sample size and the sampling of patients from four different child clinics in Cross River State, which together provide a representative description of the population. Limitations to our study that must be acknowledged include reviewing and analysing only the health records of children who attended the four included child eye clinics. Children who failed vision screening at school and then did not attend referral visits were not represented. Children living in rural areas or who have guardians with limited literacy regarding the importance of healthy vision will be disproportionately affected by this exclusion. Data about children who was referred or self-referred was not collected at the clinics. There are also no data on best-corrected visual acuity in the children who were prescribed spectacles, and there was no follow-up data on children referred for specialist care.

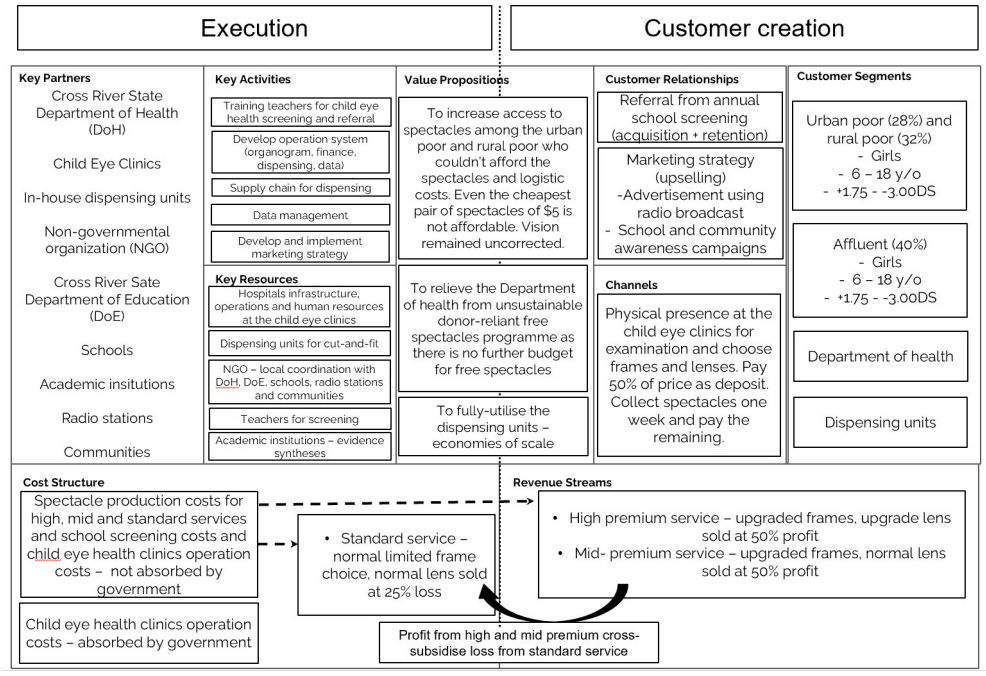

Figure 1 Proposed spectacle cross-subsidisation strategy.

The description of the demographic characteristics and ocular needs of the child population of Cross River State, Nigeria, in this study will help the Nigerian government develop and implement a sustainable cross-subsidisation programme for children's spectacles. This study indicates that demand for spectacle correction will be high in settings where there is widespread screening. Profits from spectacle sales to high-income and medium-income families will, if structured appropriately, subsidise the cost of spectacles for families otherwise unable to afford them (figure 1). However, further research is needed to understand an appropriate price structure to create a sustainable programme. Other evidence from this study helpful in creating a cross-subsidisation programme includes the narrow range of most refractive errors and the higher proportion of girls with refractive errors.

The findings from this study support the creation of a sustainable cross-subsidisation programme for spectacles that would help reduce preventable visual impairment among the children of Nigeria.

Author affiliations
[1]Centre for Public Health, Queen's University Belfast, Belfast, UK
[2]Harvard T H Chan School of Public Health, Harvard University, Boston, Massachusetts, USA
[3]Zhongshan Ophthalmic Centre, Sun Yat-Sen University, Guangzhou, Guangdong, China
[4]Nelson R Mandela School of Medicine, University of KwaZulu Natal, Durban, KwaZulu Natal, South Africa
[5]Wenzhou Medical University Eye Hospital, Wenshou University, Wenzhou, Zhejiang, China
[6]College of Health Sciences, University KwaZulu Natal, Durban, South Africa

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Competing interests VFC is a Trustee of Vision Aid Overseas, a non-governmental organisation delivering refractive services in LMICs, including Africa. NC is the Director of Research for Orbis International, an organisation that delivers eye care, including children's refractive services, in Africa and other settings.

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ORCID iD

Ving Fai Chan http://orcid.org/0000-0002-4968-7953

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