

Impact Evaluation of the VFAN-supported National Primary Eye Care Programme: Summary Report



Foreword

In Africa, there are an estimated 5.9 million blind and another 26.3 million visually impaired. These figures have been the focus for advocacy and government prioritisation. Universal health coverage and “leaving no one behind” are enshrined in the Sustainable Development Goals (SDGs). The Global eye health action plan, in alignment with the SDGs, has identified three main goals:

- a. A world in which nobody is needlessly visually impaired*
- b. Those with unavoidable vision loss can achieve their full potential*
- c. Universal access to comprehensive eye services need to become an integral part of **primary health care** and health systems development*

The Framework on integrated people centred health services seeks to achieve equitable geographical access to services, high quality and financially sustainable care and a shift from hospital based, disease-based and self-contained “silo” curative care. It includes the empowerment of people to make appropriate decisions about their own health and health care, exercise control over decisions about their health and that of their communities as a response to health as a human right.

This summary report of the “**Impact Evaluation of the Vision For A Nation (VFAN) supported National Primary Eye Care Programme**” shares Rwanda’s experience and lessons learnt relevant to other countries of sub-Saharan Africa. The programme focused on integration of eye services into primary health care services specifically eye health service delivery by general health workers at front line health facilities. It demonstrates what can be achieved by a partnership between non-governmental organisations and ministries of health with strong political commitment and its own technical expertise.

Even in the face of competing priorities, Rwanda was able to integrate eye health in health systems and policies; eye drugs in essential medicines list and the procurement and supply system, inclusion of eye health in insurance schemes and health management information system. By October 2016, nearly 1 million eye examinations had been conducted, nearly 3,000 nurses trained, and PEC was accessible in every health centre. An outreach by the nurses to every community filled the last gap; that is between the front-line health facility and the home.

A unique feature of the programme has been the consistent provision of evidence for decision making and for advocacy through a partnership with a global research institution. For example, the programme at onset provides evidence that over 34% of the population can benefit from primary eye care, over 30% of the 40+ years age group need near glasses, and patients' awareness on potential treatments for eye care was just 50%. The study also showed that the methodology of training and the inclusion of eye health in the general nursing curriculum was effective. If there was any doubt, the evaluation of the impact of this programme also provides the evidence for integration of PEC into PHC in terms of its benefits to children and their teachers in the correction of refractive errors and provision of glasses as well as improved quality of life of patients with early treatment. It showed that universal eye health coverage can be achieved.

Challenges of sustainability include human resource availability and supportive supervision, and whether on termination of programme funding by the non-governmental partner, the revolving fund strategy would completely fill the gap. How Rwanda

meets these and other challenges, maintains and builds on gains made would continue to provide lessons to other countries.

With the foundation which has been laid, the three goals of ***“Leaving no one behind”***, ***“those with unavoidable vision loss can reach their full potential”*** and ***empowerment of people as envisaged in the WHO framework***, can only be easier to achieve. Linking interventions through strengthened, coordinated and integrated referral and feedback systems vertically and horizontally are possible. It is hoped that the tripod of political commitment, partnership and evidence will continue, innovations will be adopted and results shared globally especially with sub Saharan African countries.

- Dr Hannah Faal



Executive Summary

Visual impairment is a global public health problem, with an estimated 285 million affected, of which 43% are due to refractive error. The Rwanda Ministry of Health (RMOH) estimates 1.2 million people have uncorrected refractive error (URE). In Rwanda there is a lack of specialist eye care, and task-shifting could provide a viable model of care to address this urgent need.

Since 2012, VFAN has been working with the RMOH to develop an innovative primary eye care (PEC) programme, drawing in lessons learnt from previous PEC models in Rwanda. This new model manages URE, minor eye conditions and more complex conditions requiring referrals through training, strengthening the eye health system and supporting the provision of PEC in all health centres. As the RMOH prepares to assume full ownership of PEC service from 2018, this report presents the findings of the VFAN supported PEC programme impact evaluation in Rwanda.

There were three core parts to the methods:

- *A national survey of the background need for PEC, with a nested knowledge, attitude and practice to eye care survey.*
- *Process evaluation of PEC, examining the implementation of the programme, based on survey of clinic attenders, structured observations of PEC courses, review of programme documents and data, and a participatory evaluation workshop.*
- *Impact study of individual diagnostic components of PEC, including in-depth interviews for impact of URE and its treatment in children. We used a case control follow up study to examine impact of conjunctivitis and its treatment, and impact of presbyopia and its treatment, looking at impact on quality of life, time use and per capita expenditure (PCE).*

We found a high level of need for PEC in the population, with 34.0% (95%CI=31.7, 36.3%) with potential to benefit from PEC. The need was greatest in those over 40 (65.0%; 95%CI=60.8, 69.0), and was higher in females than males (OR=1.30 (95%CI=1.15, 1.47)). The weighted prevalence of URE was 2.2% (95% CI=1.7, 2.8) and over a third of the population aged 40 and over would benefit from reading glasses (33.0%, 95%CI=29.4, 36.9). Over a quarter of participants reported conjunctivitis symptoms that could benefit from PEC (28.0%; 95%CI=25.8-30.3%), with higher levels of need in those who were older. Nearly three quarters of people surveyed were aware of eye care services in health centres, however, 70% of these participants considered poor eyesight as a normal part of ageing, with nearly half unaware of potential treatments for poor vision in old age.

The structured assessment indicated that the PEC provided is consistent with the PEC training, with over 90% of the clinical examination processes conducted correctly. This evaluation also suggests that the training received was effective in developing nurses' skills to deliver consistent PEC care. A majority of the nurses (87%) were satisfied or very satisfied with their work. Key medications and clinical protocols were not available in all health-centres, which limited the potential impact and consistency of the service. Eye-drops could not be dispensed from outreach services, which also reduced access to treatment for some patients, with only 55%

having obtained eyedrops in the sample of conjunctivitis patients in the impact study.

Programme monitoring data showed nearly a million PEC eye examinations had been conducted by October 2016, and 2707 nurses trained, with increased numbers since the time limited outreach services began in September 2017. Patient records are recorded in a PEC consultation book, which limits the co-ordination of care and information flows between different care episodes.

The development of the eye health system was an important enabler in the implementation of PEC. Leadership from the RMoH and partnership working across the sector provided the political commitment for PEC to be integrated into primary care services. The political support also allowed important policy changes to improve access to PEC, such as the inclusion of eye-drops on the essential medicines list and PEC on insurance benefits, integration of PEC indicators on the health management information systems and integration of the PEC curriculum into the general nursing school curriculum. Additional enablers to the success of the PEC programme include delivery of training and refresher courses for primary care nurses by VFAN, raising awareness of new PEC services and eye health, developing an effective supply chain of glasses, routine provision of PEC services in local health centres and outreach services to villages to improve access.

Challenges encountered in the implementation of the programme include high turnover of PEC nurses, which was partially countered by the integrated PEC training in nursing schools. VFAN have supplied reading glasses to be sold in PEC, where the generated income was deposited in a central RMoH revolving fund that has been ring-fenced for further delivery of PEC services from 2018. However, there was limited communication on the status and defined purpose of the revolving fund to stakeholders, which have led to perceived uncertainty in the sustainability of PEC. Additionally, this payment can still remain prohibitive for people from the poorer households, as evidenced by wealthier people purchasing glasses in the impact study. The competing priorities for primary care nurses from other more common conditions limited the delivery of PEC clinics, though these specialised sessions, together with outreach services can increase experience. There were reports of inconsistency in the contents and frequency of supervision, and suitable models of training and supervision are required to provide a supportive environment to develop PEC nurses skills, and assure quality of the eye care delivered.

IMPACT

We interviewed 14 children and their caregivers regarding the impact of URE and its correction. From the analysis, we concluded that the main difficulties were noted before children were prescribed glasses, include reading the blackboard, and completing homework. Teachers were often the first person to notice difficulties for a number of children. The reported main improvements after glasses were ability to read the blackboard, homework completion, and school performance. A few families also noted difficulties in socialising before glasses, but after their child wore glasses, they noticed improvement in their child's confidence and motivation at school. Some families reported difficulties in care seeking for vision conditions at Kabgayi. There were also misconceptions about glasses amongst some participants, and negative attitudes towards glasses were also reported.

To examine the impact of conjunctivitis and conjunctivitis treatment, we recruited 53 cases

from outreach clinics and 346 controls with 96% response rate at follow up. As eye-drops are prescribed at outreach but dispensed at health-centres, we found that 54.9% of cases had received treatment by follow up. We found that people who were identified with conjunctivitis in PEC clinic had poorer health-related quality of life (HrQoL) and visual quality of life (VrQoL) compared to the community-recruited controls. Patients with conjunctivitis also reported less time spent on productive and leisure activities compared to the control group. These differences remained at follow up. This finding indicates that diagnosis and treatment at PEC for conjunctivitis did not have an impact on quality of life or time use in this study. This result may be due to low levels of treatment, or other underlying factors that affect their quality of life, experience and time use, such as other health issues.

In the impact of presbyopia and presbyopic correction study, we had complete data for 152 people with presbyopia and 127 community dwelling people without presbyopia (controls). At baseline, people with presbyopia reported a significantly poorer VrQoL compared to people without presbyopia. At follow-up, 81 (54.4%) of the people identified as presbyopic had purchased glasses, and 79% participants who bought glasses continued to wear them at follow up. We detected improvement in all aspects of vision related functioning (perceived eyesight function, daily activities related to eyesight, social functioning and wellbeing related to eyesight) at follow up, particularly for those who had purchased glasses. In the adjusted analysis, we found that presbyopes who bought glasses also experienced significantly better VrQoL compared to those without glasses, even though they had similar levels of functioning at baseline, indicating that correction with glasses purchased from PEC significantly improved the VrQoL for people with presbyopia. However, there was no difference in general HrQoL between people with presbyopia and non-presbyopes after accounting for differences in age, sex and socio-economic status (SES). HrQoL instruments may be too crude to pick up small changes due to presbyopic correction – particularly since glasses are not worn all the time. There was no evidence of an association between presbyopia and time use, nor between presbyopic correction and time use in any of the activities reviewed after adjusting for age, sex and SES at baseline or follow-up.

People with presbyopia reported higher levels of overall expenditure (a proxy for income) compared to those without at baseline. This difference was not apparent at follow up, as expenditure for food decreased in the time between baseline and follow up for cases, but not controls. This pattern was evident even when differences in age, sex and SES were taken into account. There was no evidence of an association between presbyopia and time use, nor between presbyopic correction and time use in any of the activities reviewed after adjusting for age, sex and SES.

In conclusion, there is a significant need for access to PEC in Rwanda. The current PEC model has been integrated well into the Rwandan health system, with nearly 3000 nurses trained and PEC accessible in every health-centre in the country. Key enabling factors in PEC implementation relate to the significant progress in the strengthening of the eye health system. PEC beneficiaries also reported improvements in visual function after purchasing ready-made glasses for treatment of presbyopia.

RECOMMENDATIONS

Based on the findings outlined in this report, we would request the eye health and care stakeholders in Rwanda to consider:

- *Maintaining a national PEC programme that meets the population need.*
- *Maintaining and strengthening partnership working between all eye care stakeholders, through the Rwanda Eye Care Technical working group, to enable further development of the eye health care system*
- *Improving co-ordination of patient-centred care across different health facilities*
- *Developing a sustainable model of training and supervision for PEC nurses and OCOs, to ensure continuity of PEC service and assure quality of care.*
- *Developing health promotion activities to raise awareness of eye health and availability of eye care, and the benefits of presbyopic correction, particularly targeting older people.*
- *Increasing ophthalmic surgical capacity to meet rising demand from cataract referrals.*

For further information and access to the evaluation technical report, please contact:
Dr. Jennifer Yip (jennifer.yip@lshtm.ac.uk).

Abbreviations

CI	Confidence Interval
DHS	Demographic Health Survey
LSHTM	London School of Hygiene & Tropical Medicine
HMIS	Health Management Information System
HrQoL	Health-related Quality of Life
MRC	Medical Research Council
NCD	Non-communicable Disease
OR	Odds Ratio
PCE	Per Capita Expenditure
PEC	Primary Eye Care
PEEK	Portable Eye Examination Kit
PVA	Presenting Visual Acuity
QoL	Quality of Life
RBC	Rwanda Biomedical Centre
RMoH	Rwanda Ministry of Health
SES	Socio-economic status
URE	Uncorrected refractive error
VA	Visual Acuity
VFAN	Vision for a Nation
VI	Visual impairment
VrQoL	Vision related quality of life
WHO	World Health Organisation

Acknowledgements

We acknowledge the support and input from the wider research team, stakeholders and partners in Rwanda and the UK that have contributed to data collection. We thank members of the VFAN team for their support and contributions.

We are also grateful to all the participants who gave their time to this study.

Table of Contents

FOREWORD	1
EXECUTIVE SUMMARY	3
ABBREVIATIONS	7
ACKNOWLEDGEMENTS	7
INTRODUCTION	9
VFAN WORK IN RWANDA	9
EVALUATION FRAMEWORK	11
Theory of change	11
NATIONAL PRIMARY EYE CARE SURVEY	13
BACKGROUND NEED FOR PRIMARY EYE CARE	14
POPULATION KNOWLEDGE, ATTITUDE AND PRACTICE	14
IMPLEMENTATION	16
PATIENT SATISFACTION	17
CLINICAL ASSESSMENT OF PEC NURSES	17
PROGRAMME OUTPUTS	17
OUTREACH	17
STRENGTHENING THE EYE HEALTH SYSTEM IN RWANDA	18
Leadership and Governance	18
Healthcare Financing	19
Healthcare Workforce	19
Medical Products and Technologies	19
Information and Research (Routine Data)	20
Service Delivery for PEC at Healthcare Centres	20
Integration	21
IMPACT OF PEC TREATMENT	22
IMPACT OF PRESBYOPIA AND ITS TREATMENT	23
IMPACT OF CONJUNCTIVITIS AND ITS TREATMENT	23
IMPACT OF URE ON CHILDREN	25
CONCLUSION	26
RECOMMENDATIONS	27
REFERENCES	28
APPENDICES	29

Introduction

Globally, there are 285 million people with visual impairment (VI), including 19 million children.(1) The leading cause of VI is refractive errors (43%), which can be easily treated through provision of glasses. Affordability and lack of access to services are major barriers to the uptake of refractive services in Africa.(2) Cataract is the second leading cause (33%), which can be surgically corrected, although uptake of surgery is often low. Uncorrected presbyopia (poor near vision) is also common, affecting most people above the age of 50.(3)

A major challenge to dealing effectively with the burden of visual impairment and eye disease is the lack of eye care personnel in Africa. This gap makes it more difficult to reach the goal of VISION 2020: The Right to Sight to reduce avoidable blindness.(5) Following from the 2008 World Health Report on universal access to primary health care, the World Health Organization (WHO) developed the global action plan for universal eye health to support the integration of primary eye care (PEC) into primary health care services.(6) PEC is part of an important global strategy, whereby basic eye services are delivered at the primary care level through general health workers who have received training in eye care. This “task shifting” strategy has been widely promoted globally(7), and offers better access to eye care, especially in rural areas.

Rwanda is a country in Central and East Africa with a population of 11.5 million. Rwanda Ministry of Health (RoMH) estimates 1.2 million Rwandans (including 32,500 aged 0-10 and 67,000 aged 11-20) have Uncorrected Refractive Error (URE), of whom 90% are presbyopic.(8, 9) Many others will have other ocular morbidities. There is a severe lack of eye care specialists in Rwanda, with only 16 ophthalmologists and 4 registered optometrists available in the entire country, and these are mostly based in urban areas (at time of evaluation). There is therefore little capacity to provide eye care services for the large rural population. Several partners have conducted models of PEC in Rwanda since 2000. A prospective evaluation was conducted on a PEC programme that was rolled out in 2007 in the Rubavu District of Western Rwanda.(10, 11) This programme trained two health workers from each health-centre, focusing on anatomy, the red eye, cataract and refractive error, and required diagnosis and referral of cataract at a VA threshold. This study recommended development of clear referral criteria to ensure effective referrals to district hospitals; referrals that accounted for both patients needs and surgical capacity. Additional training needs were identified to cover for absence due to shift working and holidays, as the study found nurses who were not trained in providing eye care delivering eye care services which reduced the potential impact of the service. Insurance coverage and cost of the services were also a factor that affected access and treatments provided. The evaluation team also highlighted the importance of ongoing monitoring and evaluation as part of any PEC programme to examine productivity and outcomes. Lessons learnt from this programme were used to develop and adapt the current PEC programme evaluation.

VFAN WORK IN RWANDA

Vision For A Nation (VFAN) has been working with the RoMH since 2012. They started an innovative project with the ambition to provide universal eyecare services in Rwanda, taking on board the concerns raised in the earlier programme.(12) VFAN worked with Dr. Wanjiku

Mathenge and the RMoH to develop their PEC curriculum. The stated goal or vision of the PEC programme is to provide nationwide access to eye care and affordable glasses for all. The initial intention, prior to the project consultation and design phases, was focused on provision of low cost adjustable glasses to underserved populations. These intentions rapidly evolved to improving access to eye care due to RMoH's assessment of the need for broader eye health services at the primary level. VFAN worked with the RMoH Technical Working Group for Eye Health and other partners to design a programme that would integrate provision of glasses with PEC through the development of a national PEC curriculum and training a PEC workforce to deliver services.

The programme includes the following activities:

- *Training of new nurses to replace PEC nurses who retire or change job and to increase the nursing capacity at each health centre*
- *Refresher training courses to nurses previously trained in PEC;*
- *Support for training of nursing students through integration of PEC curriculum into general nursing curriculum.*
- *Provision of ophthalmic clinical officer (OCO) supervision of nurses*
- *Ensuring an effective supply chain (e.g. glasses, eye drops)*
- *Community outreach in each village in Rwanda to raise awareness of eye health and more recently, provision of PEC by trained nurses in village locations.*
- *Public awareness raising through radio and poster campaigns*
- *Monitoring of activities (eye screenings, glasses and eyedrops dispensed and referrals made) provided by OCOs and nurses.*

These activities allowed PEC services to be provided in local health centres as well as in villages during outreach to facilitate access. The programme aimed for PEC services to be delivered at health-centres at least once a week by trained nurses. In addition to providing PEC services in health-centres, which serve approximately 30 villages each, trained nurses also travelled to individual villages and offered eye care through an outreach programme. Glasses were also provided during outreach services, but eye drops were prescribed and subsequently dispensed in the health-centre. All activities were monitored and data analysed by the VFAN team in Rwanda.

The PEC nurses' main activity was to detect and treat URE (adults only; primarily presbyopia) and minor eye diseases, in addition to referring beneficiaries requiring additional eye care services to district hospitals.

Skills included:

- (a) recognising and managing a painless red eye with good vision (microbial conjunctivitis, allergic conjunctivitis and dry eye)*
- (b) dispensing correct eye drops for red eye;*
- (c) accurate assessment of near vision with diagnosis and management of presbyopia through dispensing reading glasses and/or innovative adjustable glasses;*

(d) accurate assessment of distance visual acuity and potential correction with adjustable glasses

(e) accurate referral of cases requiring secondary/tertiary care for

- URE in children (<16 years)
- Visual impairment (VA worse than 6/12, better than 6/60 that does not improve with pinhole)
- Cases with abnormal ocular appearance requiring further assessment as outlined in the PEC handbook
- Defined eye emergencies (including VA worse than 6/60 and other cases outlined in PEC handbook)

All children under age 16 with URE are referred onward for custom-made glasses at hospital level, and adults are also able to request this same service. The impact of URE on working age adults was not assessed, although they were included in the original scope, due to lack of cases identified in PEC during the evaluation fieldwork.

There are two primary ways in which the programme is expected to have a beneficial impact. First, provision of eye care at the primary level is anticipated to improve access to eye care and to reduce the number of people seeking care at the secondary or tertiary level, as evidenced in South Africa.(13) Second, it is anticipated that provision of PEC will improve productivity, education, employment, and quality of life. This has been shown for cataract and cataract surgery,(14) but has not yet been demonstrated for components of PEC in Africa.

Aim

The aim of the impact evaluation is to assess: 1) the need for PEC in Rwanda, 2) how well the VFAN supported PEC Programme in Rwanda is working, and 3) what the impact is on the lives of beneficiaries.

Objectives

The objectives of the evaluation that are covered in this report are:

Identify need for PEC:

1. To assess the need for PEC in the community

Identify how well the programme is working:

2. To analyse existing monitoring data and compare with predefined programme metrics
3. To survey the profile of the patients attending for PEC
4. To understand the knowledge, attitudes, behaviours and practices around PEC in the community
5. To assess the competency of the nurses trained in PEC
6. To conduct a participatory process evaluation of the VFAN supported PEC programme in Rwanda.

Identify the impact of the programme in:

- People aged 40 and over with presbyopia
- Children with URE
- People with conjunctivitis

EVALUATION FRAMEWORK

The evaluation framework was based upon: 1) The Theory of Change for the PEC programme developed in partnership with Rwandan stakeholders, 2) The conceptual framework on healthcare access, and 3) Consideration of quality of care.

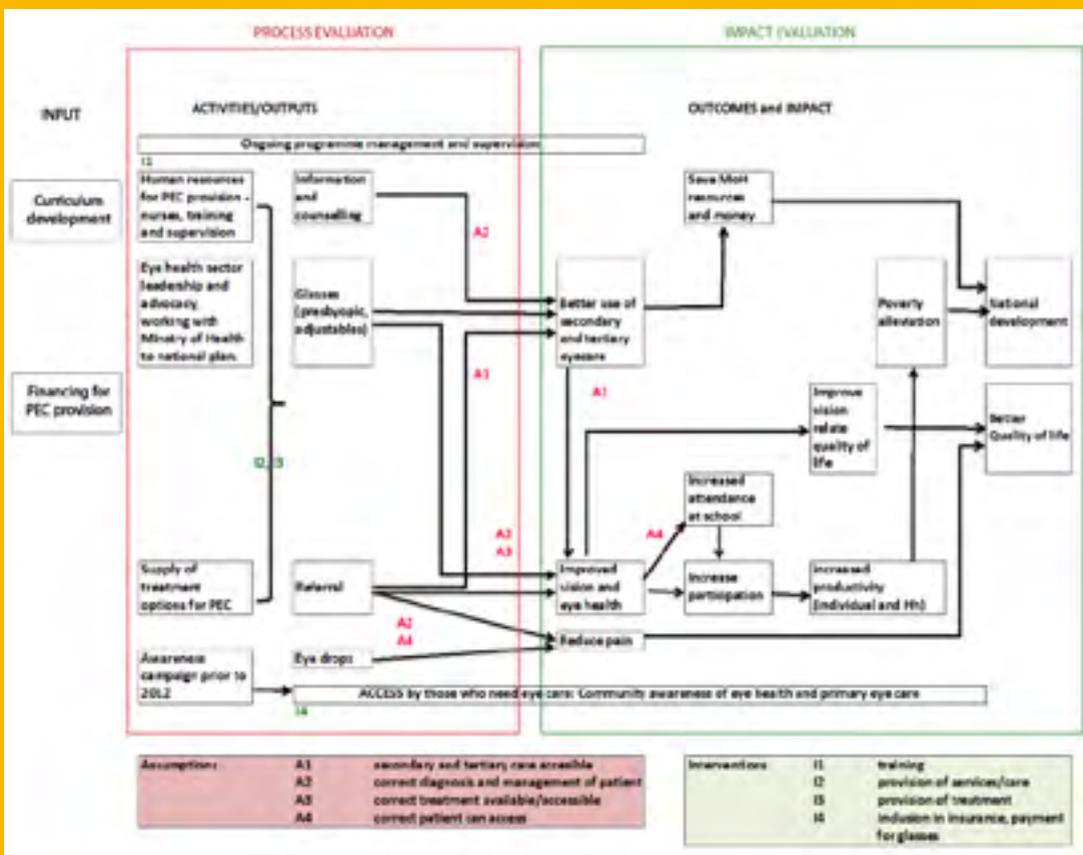


Figure 1: Theory of Change for VFAN supported Primary Eye Care programme

Theory of Change

During a scoping visit in May 2016, the LSHTM research team (HK and JY) conducted a theory of change workshop with participation by the programme team (country director, members of education team), members of VFAN (SF) and an independent consultant (DM). Together, we co-produced a theory of change that underpins the potential impact of the PEC services and how the services could improve the lives of the beneficiaries and for the population of Rwanda. The initial theory of change was further refined during the evaluation and presented in the process evaluation workshop (*Figure 1*).

The inputs identified at the health system level include curriculum development (supported by Fred Hollows) and financing for the provision and implementation of PEC. The VFAN activities that contributed to the development and implementation of the programme included training and education of PEC nurses, with supervision, leadership and advocacy through working with the RMoH and supply of treatment options for PEC.

The key activities of the service delivery identified were reassurance and counseling for people who did not have an eye condition, but have sought eye care, glasses for those with presbyopia, provision of glasses for people with presbyopia, referrals for those with more complex eye problems and eye drops for the treatment of conjunctivitis.

Identified key outcomes for the programme were improved quality of life for people in Rwanda and national development, although these are above the line of attribution for the current evaluation. Outcomes that we planned to evaluate include quality of life, vision related quality of life and increased productivity. An additional key outcome was better use of secondary and tertiary eye-care services.

Assumptions underlying the pathway to change and impact included considerations of access and quality of care. This includes effective delivery of service where the structures and processes are in place, including adequately trained nurses, materials and equipment for diagnosis and treatment of PEC conditions are available, the target conditions are *appropriately managed, and there is sufficient capacity to address the demand for services*.

National Primary Eye Care Survey

A national survey was conducted between September and December 2016 amongst people aged 7 and over in Rwanda. We used a two-stage sampling process with support from the National Institute of Statistics Rwanda, to select 5 clusters (villages) in 10 districts.

Data collection

Trained interviewers conducted interviews and eye examinations in participants' homes in Kinyarwanda. We collected information on household assets and characteristics, individual socio-demographic, general and eye health factors

The interviewers also assessed visual acuity of all participants using the smartphone based Portable Eye Examination Kit (PEEK). We assessed reading vision in all participants aged 40 years

and over using the Rwandan clinical near vision screening test. In line with local clinical practice, for those who were unable to complete the test as they could not identify words or numbers we used self-reported near vision.

Definitions used are outlined in **Table 1**.

We estimated weighted prevalence to ensure they were representative of the population, and logistic regression to look at the relative risk of needing PEC for women. All statistical analyses were conducted using Stata 14.

The results of the national survey have been published and an overview of findings is outlined below.

BACKGROUND NEED FOR PRIMARY EYE CARE

There is a high level of population need for PEC in Rwanda. Overall, the estimated need for PEC in the population was 34.0% (95%CI=31.7, 36.3%). The need was greatest in those over 40 (65.0%; 95%CI=60.8, 69.0), and was higher in females than males (OR=1.30 (95%CI=1.15, 1.47).

The weighted prevalence of URE was 2.2% (95% CI=1.7, 2.8). Spectacle coverage for distance vision was 18.3% (95%CI=13.8, 23.5). Of the 1158 participants who were aged 40 and over, 351

Table 1: Definition of outcomes	
Outcome	Definition
URE	PVA worse than 6/12 (>logMAR 0.3) in the better eye that corrects to better than 6/12 (≤logMAR 0.3) with pinhole.
Need for reading glasses	<ul style="list-style-type: none"> • Aged over 40 and • PVA better than 6/12 (≤logMAR 0.3) in worse eye, and • Unable to read N8 chart. <p>Those who stated they could not read words or numbers and unable to read the chart when shown were also asked about self-rated near vision. Those reporting cannot see at all, or great difficulty in seeing close objects were also categorized as need reading glasses.</p>
VI requiring referral	PVA worse than 6/12 (>logMAR 0.3) in the better eye that does not correct to 6/12 with pinhole.
Symptoms that may benefit from PEC	Any symptom response of moderate or worse (graded 4 or more on the 5 point scale) to any individual questions in the symptoms questionnaire
Need for PEC	Using definitions above, participants fulfilling criteria for: <ul style="list-style-type: none"> • URE • Need for reading glasses • VI requiring referral • Symptoms that could benefit from PEC

URE = uncorrected refractive error; PVA = presenting visual acuity; PEC = primary eye care; LogMAR = logarithm of minimal angle of resolution; VI = visual impairment

participants could not read nor recognize numbers, and 807 (69.7%) completed the test.

We found over a third of the population aged 40 and over would benefit from reading glasses (33.0%, 95%CI=29.4, 36.9). The population prevalence of presbyopia in people aged 40 and over was 39.4% (95%CI=35.8, 43.2%) based on those we identified with need for reading glasses and participants with glasses who were able to read or had good reported near vision, with good distance vision. The presbyopic spectacle coverage was 16.3% (95%CI=15.1, 17.4).

Population prevalence of need for referral from PEC to secondary care was 1.5% (95%CI=1.2, 1.9%) consisting of people who had PVA<6/12 in better eye, which could not be corrected with pinhole.

Over a quarter of the participants reported symptoms that could benefit from PEC (28.0%; 95%CI=25.8-30.3%), with higher levels of need in those who were older. The most common symptom was itch (21.8%; 95%CI=20.6, 22.9) and watery eyes (17.4%; 95%CI=16.3, 18.5) indicative of allergy related conjunctivitis, with lower levels of need reported for sore (1.2%; 95%CI=9.2, 15.5) swollen (3.3%; 95%CI=2.8, 3.9) or sticky eyes (5.9%; 95%CI=5.3, 6.6), which are suggestive of infectious causes.

POPULATION KNOWLEDGE, ATTITUDE AND PRACTICE

A sub-sample of 152 participants (3 or more per cluster) were selected for a knowledge attitudes and behaviour questionnaire to assess their knowledge of eye diseases, attitude towards eye health and practice in access to eye care, with answers were derived from the Rwanda national census survey on healthcare where possible.

Of 152 responses, 50.0% were women and the mean age of respondents was 45.9 years, with age range from 15-87 years. A small proportion of participants in the KAP did not have health insurance (12.5% 95%CI=8.1%-18.9%)

Over 80% of people who participated in the survey were aware of refractive errors, and similar proportions knew of cataracts. There was less awareness of posterior segment eye disease. Nearly a 15% of participants of the KAP survey had been informed that they had a refractive error, and people reporting refractive error were older (mean age 59.0 presbyopia vs 43.8 without presbyopia and mean age 54.1 vs 44.6 for refractive error), with no differences between proportions of men and women.

Of 152 participants 69.7% agreed that it was normal to have poor vision when you get older, and similarly 69.7% did not consider that glasses were only for rich people. There was no strong indication that participants considered eye treatment to be more expensive compared to other treatments at health centres.

We asked participants if they had an eye health consultation within the past year, and in those that had not, we asked what they would do if they had an eye problem. Of 152 responses, 40 (26%) had an eye health consultation in the past year and 112 (74%) had not. Traditional healers do not appear to be used for eye health consultations, with nearly all respondents stating they would seek eye health care with a doctor or nurse. Over 90% would seek care in health centres or public hospitals. These results indicate there is good awareness of where to seek eye healthcare.

Implementation

We examined how successful the implementation of PEC was using the Medical Research Council (MRC) process evaluation framework (15), based on findings from:

- *survey of clinic attenders*
- *structured observations from an ophthalmic clinical officer*
- *in-depth interviews with key people involved in the programme*
- *review of programme data and published documents*
- *participatory workshop with key stakeholders to review the collated evidence and make recommendations for further development to ensure sustainability of the service.*

Data collection

Clinic survey: We surveyed attendees at the PEC clinic that served each of the 50 villages to determine their satisfaction with the services received. We limited numbers for each PEC session at 30 attenders to ensure quality of data collection.

Stakeholder interviews: Semi-structured in-depth interviews were conducted in English by an experienced researcher or in Kinyarwanda by a trained local fieldworker. We asked about implementation of the programme (including training and supervision), benefits and shortcomings of the programme. Nineteen interviews were conducted including 8 implementers, 5 VFAN personnel and 6 key stakeholders in Rwanda.

Structured Observations: A structured observation, based on the PEC curriculum was conducted by a Rwandan Ophthalmic clinical officer (OCO), who was also a PEC trainer and therefore familiar with the clinical flow charts and competence requirements of PEC nurses. The OCO observed each PEC nurse examinations for one clinic session on the first two patients, allowing time for guidance and supervision where required. We aimed to sample 30 nurses working in fifteen different health centres. We also interviewed the nurses using a questionnaire to determine their experience and views on training and supervision, and job satisfaction.

Programme Data and Document review: Key programme documents from VFAN were reviewed together with available documents from the Rwanda Ministry of Health (16) and published literature to provide context and background to the development and delivery of PEC in Rwanda. (10-12, 17) The programme office also supplied an overview of the programme monitoring data and referral data.

Participatory process evaluation workshop: An independent expert reviewed the process evaluation data (Dr Hannah Faal). Following this review, findings were presented at a process evaluation workshop held in Kigali. The aims of the workshop were to: corroborate data, agree interpretation of key findings, identify areas of good practice, identify challenges, and determine next steps for further development of PEC in Rwanda. Attendees participating in the workshop are shown in **Appendix 1**. Those who were unable to attend in person provided written feedback and input.

Analytical framework

We analysed all described elements of collected data using an integration of the MRC process evaluation framework (15) and the theory of change (*Figure 1*) and the World Health Organisation (WHO) Health Systems framework to examine contextual factors.

The source of data for each component of the analytical framework is in *Appendix 2*. For all framework elements, we used primary data with triangulation from an alternative source.

PATIENT SATISFACTION

We surveyed 858 attendees at the 13 health centres and 30 outreach clinics, of which 21% were patients at health-centres and 78% at village outreach clinics. Of these, 49.3% (95%CI=45.1-53.5%) reported high levels of satisfaction with the service, with 24.4% (95%CI=17.2-23.9%) reporting low levels of satisfaction, the remainder reporting moderate satisfaction. People who attended outreach were nearly twice as likely to report high satisfaction compared to those attending at health-centres (Odds ratio (OR)=1.97, 95%CI=1.25-3.10).

CLINICAL ASSESSMENT OF PEC NURSES

The clinical OCO assessment took place between February 2017 and June 2017, where we assessed and interviewed 30 nurses in 19 different health centres. The structured assessment indicated that the PEC provided is consistent with the curriculum, with over 90% of the clinical examination processes conducted correctly. This also suggests that the training received was effective in developing nurses' skills to deliver consistent PEC care. A majority of the nurses (87%) were satisfied or very satisfied with their work.

PROGRAMME OUTPUTS

Outputs from the PEC programme between November 2012 to October 2016 is shown in *Table 2*. Over 350,000 eye examinations were conducted in PEC through the VFAN supported programme, with over 50,000 refractive errors diagnosed and over 38,000 referrals made to secondary care.

OUTREACH

The PEC curriculum was designed for delivery at primary care and health centres. In 2015, a time-limited outreach programme was proposed and initiated with external funding. Consequently, all villages had received two outreach PEC clinics by the end of 2017.

The driver for this change in PEC delivery was to increase uptake and raise awareness of PEC. There are mixed views on the impact of outreach PEC as demonstrated from interviews from stakeholders, with concerns on sustainability of the programme and competing priorities for the PEC nurses who have multiple responsibilities.

As a consequence of the outreach, the numbers of eye examinations substantially increased (*Table 2*), allowing PEC to reach proposed targets outlined in the memorandum of understanding with the RMoH. PEC nurses were not able to provide eye drops as treatment in outreach as this required a prescription dispensed at the health-centre. We found in the conjunctivitis

Table 2: Outputs from the VFAN supported PEC programme

	Nov 2012 - Sept 2015 Before outreach	Sept 2015 - Oct 2016 After outreach	Total
<i>Number of PEC eye examinations</i>	352,830	619,465	972,295
<i>Need for reading glasses</i>	54,709	84,648	139,357
<i>Referrals made</i>	38,657	63,734	102,391
<i>Number of villages reached through outreach (total=15,000)</i>		11,487	11,487
<i>Number of OCOs trained as PEC trainers</i>			32
<i>Number of nurses trained</i>			2707

OCO=ophthalmic clinical officers

impact study that 45.1% had not received eyedrops at follow up, at least 3 weeks later. Delivery of outreach required additional payments for travel and nurses' time, which made cost per examination more expensive. Some stakeholders also stated this raised expectations from PEC nurses on payment for PEC services.

There were also concerns that provision of PEC in villages would change attitudes to PEC and patients would not travel to health centres for further access. However, patient satisfaction at outreach was high (see above).

STRENGTHENING THE EYE HEALTH SYSTEM IN RWANDA

During the course of implementation, to increase uptake and reach of PEC, VFAN worked with and through the local eye health system to integrate PEC into the Rwandan primary health care system. Key enablers and challenges to implementation are discussed below, using the WHO health systems framework.

Leadership and Governance

Engagement and support from the RMoH to the eye health sector (joint paper published (12) and Memorandum of understanding) provided the political leadership and influence to enable establishment of PEC activities.

RMoH support and advocacy from eye care partners was a key factor in driving other enabling factors such as inclusion of PEC in community insurance reimbursement (Mutuelle de Sante), inclusion of antimicrobial eye drops on the list of essential medicines, and inclusion of PEC indicators on the health management information system (HMIS). Though there is continued support from RMoH, eye care sits within the non-communicable disease (NCD) division, where there are competing priorities with high profile conditions such as diabetes and cancer.

Stakeholders also stated that the MOH technical working group for eye health could be strengthened, and RBC taking a leadership role for the eye-care sector.

Healthcare Financing

The financial investment from external donors prior to establishment of the service was also an important enabler. These funds provided the pump priming finance required to implement a national PEC programme, through curriculum and workforce development. The inclusion of PEC in the community health insurance scheme, together with high level of insurance coverage (79.5% in the population survey) enabled access to eye care.

The PEC programme also provided reading glasses, with payments from patients (1000RWF) pooled into a RMoH revolving fund allocated for financing future PEC and eye care service delivery. Though the memorandum of understanding between RMoH and VFAN outlines the commitment to allocate healthcare staff and resources to support delivery of PEC, there was also a lack of clarity amongst stakeholders on the financial commitment from the RMoH, and the status of the RMoH revolving fund. VFAN also provided the stockpile of glasses, which can sustain the services in the near future. Another consideration is the cost of the glasses, though considered low, may still be prohibitive for the poorest.

Healthcare Workforce

The current PEC programme incorporated learning from previous PEC experience in Rwanda in order to improve outcomes. This included the establishment of the national PEC curriculum, a key foundation to improving the quality of care delivered. The new programme curriculum provided a set of clinical care protocols, appropriate for the skillset of primary care nurses, which increased consistency of services delivered. It also provided a clear structure for competency-based training of the PEC workforce.

Training and supervision of a skilled PEC workforce is an important component of strengthening the eye-care system. Prior to the current programme, there were few general health workers trained in PEC and limited capacity of specialist services. The current programme has trained over 2,700 nurses, with at least two trained PEC nurses employed in each health-centre.

The PEC training curriculum has been integrated into Rwandan nursing schools training to overcome initial high turnover of PEC nurses. As new cohorts of nurses enter the workforce, they may need additional support to raise confidence as they gain experience in PEC. Additional quality assurance through comparisons with current in-service training is required. On-site training using peer networks with OCO supportive supervision can also have a role in continued quality assurance of PEC.

Medical Products and Technologies

In order to ensure successful delivery of PEC in local health-centres, VFAN worked to assure the inclusion of eye drops (antimicrobial and anti-allergy) on the essential medications list. Therefore, patients diagnosed with conjunctivitis are able to obtain the required treatment at the locality of diagnosis rather than attending local pharmacies, which are private businesses. The outreach

service could not dispense eye drops, and consequently, only 55% of patients who required treatment had received it three weeks or more later, which limited the effectiveness of the service.

The VFAN programme also secured the supply chain for non-prescription reading glasses and adjustable glasses, again allowing successful treatment at the point of contact in health centres, as well as developing a route towards financial sustainability for the service. During the fieldwork in health centres, we were unable to recruit any working age adults with URE who would be offered the adjustable glasses, likely due to low background need.

Information and Research (Routine Data)

Referrals are not routinely followed up and information between PEC and district hospitals are not linked. Outcomes of referrals to secondary care are reported to the VFAN programme management team, with the assumption that referrals came from the VFAN supported programme.

Since the implementation of the national PEC programme, PEC indicators have been included into the HMIS data, which is co-ordinated by RMoH. This will support the sustainability of the programme as central monitoring will facilitate continued delivery. However, access of this data can be difficult, and the eye health system can make better use of the data to examine variations in demand and provision, and in the future, inform service development.

During the clinic survey, we noted the PEC clinic records for one month and subsequently compared the figures to monitoring data recorded by the programme team in 21 clinics. We found that in 57% (n=12) of cases the number seen in PEC according to the VFAN monitoring data was higher than the number we had recorded at the corresponding health centre. The percentage difference ranged from 16%-179% higher. In 33% (n=7), records were the same, and in 10% (n=2) of cases the number recorded by VFAN was lower than recorded in the health centre books. There was no evidence of a statistical difference between the 2 sets of data. However, due to the small numbers, we cannot draw any firm conclusions. Errors in routine data, particularly those that are manually transferred, are common, though the direction of errors in this small comparison requires further investigation to improve accuracy and strengthen future monitoring.

Service Delivery for PEC at Healthcare Centres

The current service is delivered at health-centres as a separate PEC clinic, at a specified time during the week, which is communicated to the patients. This allows for PEC nurses to consolidate their skills in focused sessions, rather than eye examinations dispersed amongst a range of other clinical examinations. Competing priorities in other areas of healthcare such as maternal health, infectious diseases can limit the capacity of the nurses to deliver PEC clinics. However, between 2015 and 2017, the provision was augmented with outreach activities, where nurses are paid to deliver PEC services in villages within the health centre's catchment area. Additional funding was sought from international aid grants to deliver two outreach PEC clinics in all 15,000 villages in Rwanda. This resulted in a significant increase in the number of examinations delivered (**Table 1**). As external donors have funded the outreach, it is time limited and intended to raise awareness and reduce the backlog in need for PEC. This increase in demand also built the level of experience amongst PEC nurses. However, some stakeholders raised concerns this may mislead service users about where to seek eye care in the future. Eye-drops were only available for people attending clinics and

not those attending PEC at outreach, where only prescriptions were available. Referrals were made through a paper-based system, and patients were instructed to attend a referral hospital with a form. There were no records of outcomes of referrals in the primary care patient record book. The outcomes of referrals are collected by district hospitals, with paper-based feedback to a central office in the health centre, but were not part of patient records (see previous).

Integration

The concept of integrated health systems is intended to improve access, quality and continuity of service. In the VFAN supported programme, PEC was integrated into the health system, though inclusion of PEC in insurance reimbursements, indicators in HMIS, medications on the essential medications list, the nursing schools. This system integration, made possible by the leadership and support from within the RMoH and from eyecare partners in Rwanda, was essential to the establishment of this programme.

Embedding PEC through delivery by primary care nurses in primary care health centres led to the horizontal integration of eye care into general health care. Though the nurses had already provided eye care in principle, previous studies have shown that the levels of knowledge in PEC was low. Therefore raising quality of care required a revised curriculum, additional training and a period of disintegration with PEC provided in separate clinics and outreach. With the inclusion of this revised PEC curriculum into the general nurses' training, this will likely result in continued supply of PEC nurses that could again, provide PEC as part of their routine clinics. However, this will require additional quality assurance and supervision to ensure new nurses attain competence in PEC.

Referrals are made to district hospitals where OCOs work. The referral information is sent back via paper returns to primary health centres and also recorded in by the OCOs and collated by the VFAN programme office. Individual referrals are not monitored in the system, and the limited number of OCOs and ophthalmologists, distant district and tertiary hospitals, make vertical integration more difficult. Maximising benefit from PEC will require other elements of the eye health system to be strengthened.

Through system integration, together with the financial legacy from the centralized revolving fund, the sustainability of the PEC service can be assured, providing there is continued leadership from RMoH and collaboration from the eye health partners, quality assurance and improvement, together with further development of the PEC and eye health system to meet the needs of the population.

Impact of PEC Treatment

For the studies on the impact of conjunctivitis and treatment for conjunctivitis and also for presbyopia and treatment for presbyopia, we used a case control with follow up approach for detection of impact.

The key areas for impact were:

- *Vision related quality of life using the WHO/PBD VF20.*
- *General health related quality of life using the adapted (for the Rwandan context) and validated Kinyarwanda version of the short form 36 questionnaire (hereafter referred to as the adapted SF36, or aSF36).*
- *Activities and time use was measured using a series of questions drawn from the Living Standards Survey of Rwanda*
- *Expenditure as a proxy for income was measured through per capita expenditure (PCE) using detailed monthly consumption data. The items were in line with the Rwanda Living standards measurement survey items and pilot tested to ensure local relevance.*

In this section “cases” are defined as those with the condition as identified by the PEC nurse in the clinical setting (conjunctivitis, or presbyopia), and “controls” are those without any eye health conditions we recruited from the community, as part of the national survey. We selected 3-4 eligible case participants for each condition from each health center where possible.

Data collection for impact of conjunctivitis occurred between January and June 2017. Conjunctivitis cases were followed up approximately three weeks after baseline to understand the impact of treatment with eye drops. For this analysis, baseline data for controls was used to compare cases at baseline and follow-up. We assumed due to the short follow up period, data for controls would not change significantly over a 3-week period.

Baseline data collection for presbyopia took place between October 2016 and January 2017, with follow up between October 2017 and December 2017. PEC nurses assessed need for reading glasses using the PEC clinical algorithm. For those unable to read the print, participants were offered ready-made glasses ranging from +1.5Dioptre (D) to 2.5D, which were selected by the participant to correct their near vision for purchase at 1000 Rwandan Francs (RWF) (approximately 1USD).

Analysis

Data analyses were restricted to cases and controls with complete data at baseline and follow-up. Differences in outcomes at baseline for cases and controls were assessed using linear regression for continuous variables (quality of life, time use) and logistic regression for categorical variables (participation in activities, self-rated health). Adjustments were made for age, sex, and socioeconomic status. Change in outcomes over time for cases was assessed using t-tests for continuous variables, and test of proportions for categorical variables. Stata version 15 (StataCorp LP, College Station, TX, USA) was used for all statistical analyses.

IMPACT OF PRESBYOPIA AND ITS TREATMENT

At baseline, we recruited 132 non-presbyopic community based participants (controls) and 168 participants with presbyopia (cases), and complete data were available for 127 of the control group (96.2%) and 152 presbyopes (90.5%) at both baseline and follow up. Of 152 presbyopes, 81 (53.3%) purchased glasses and 68 (44.7%) did not, with missing data on glasses purchase in three participants.

Of the 81 participants who purchased glasses, 79.0% still had their glasses at follow up. The main reasons for not wearing glasses include broken (59%), stolen (18%), did not help vision (12%), uncomfortable or considered poor quality (both 6% each).

The mean age of participants was 52.7 years (range 40-87) and 56.3% were women. People who bought glasses were wealthier and healthier than those who did not, with higher proportions in the wealthiest quartile (28.4% vs 4.7%, $p < 0.01$) and higher proportions reporting good or excellent health (25.9% vs 11.8% $p = 0.03$). There were no differences in other characteristics including age, sex, education and self rated vision.

This impact study has found that at baseline, people with presbyopia reported a significantly poorer VRQoL compared to people without presbyopia, and we detected statistically significant improvement in all aspects of vision related functioning (perceived eyesight, daily activities related to eyesight, social functioning and wellbeing related to eyesight) after diagnosis for those who purchased glasses (*Figure 2*). These results indicate that correction with glasses purchased from PEC significantly improved the VrQoL for people with presbyopia.

Overall, there was no difference in general HrQoL between people with presbyopia and non-presbyopes after differences in age, sex and SES had been accounted for. It is not surprising that there was not much impact on general HrQoL as these measures may be too crude to pick up small changes due to presbyopic correction – particularly since glasses wouldn't be worn all the time, and not all participants who bought glasses continued to wear them at follow up.

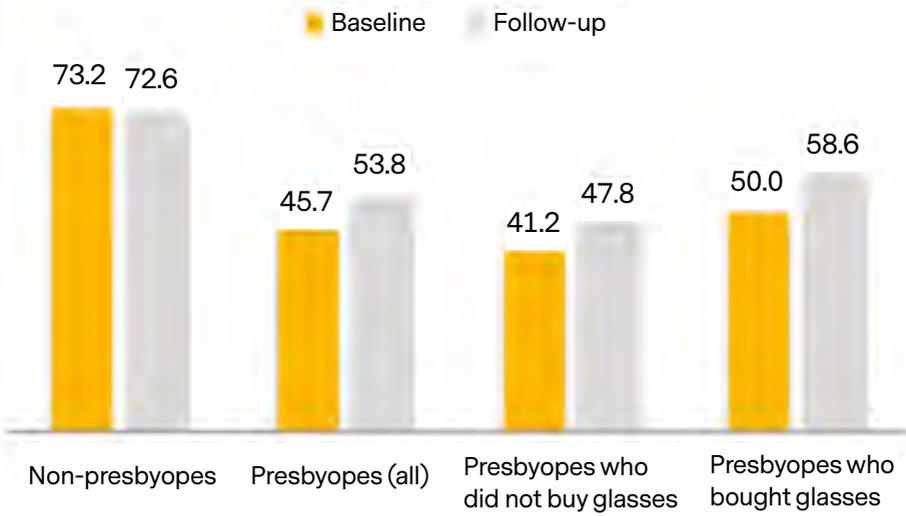
There was no evidence of an association between presbyopia and time use, nor between presbyopic correction and time use in any of the activities reviewed after adjusting for age, sex and SES.

We found that people with presbyopia had higher levels of overall PCE compared to those without at baseline, but not follow up, as expenditure for food decreased in the time between baseline and follow up for cases, but not controls. This was evident even when differences in age, sex and SES were taken into account.

IMPACT OF CONJUNCTIVITIS AND ITS TREATMENT

The baseline survey included 53 cases with conjunctivitis and 346 controls. An additional 8 cases under 18 were found at baseline, however due to the small sample size, we have excluded these children from the analysis. The follow-up survey included 51 cases and 346 controls (96% response rate). Two people could not be located at follow-up. The median length of follow-up was 50 days (range 22-113 days) for cases. This is longer than the planned follow-up of 21 days, due to logistical challenges with locating participants.

Eyesight rating



Psychosocial Function

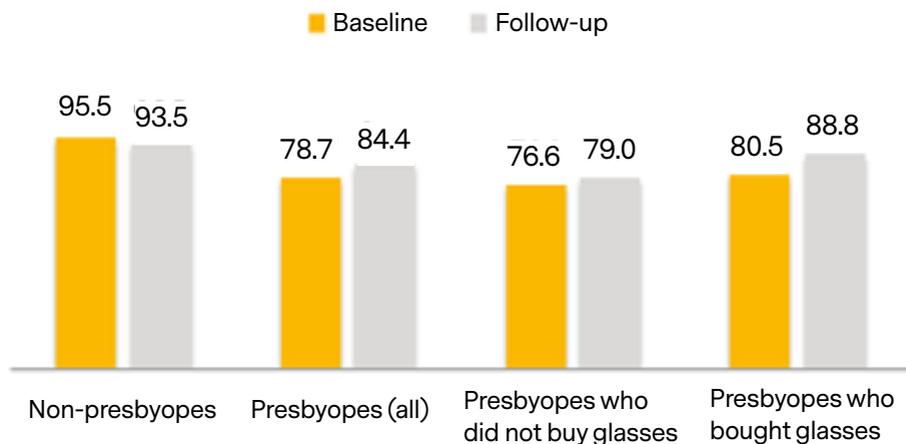


Figure 2: Change in Eyesight rating and Psychosocial function between baseline and follow up for presbyopes and non-presbyopes

As cases were identified through outreach, and in this setting eyedrops are not provided, at follow-up cases were asked whether they had actually received the treatment. This revealed that only 54.9% of cases received treatment. Analysis was conducted to see whether quality of life scores differed between cases who did and did not receive treatment, and no differences were found.

People who were identified with conjunctivitis in PEC clinic had poorer quality of life and visual quality of life compared to the community recruited controls. Patients with conjunctivitis also reported less time spent on productive and leisure activities compared to the control group at baseline. These differences remained at follow up. This indicates that diagnosis and management at PEC for conjunctivitis did not have an impact on quality of life or time use in this study. Over half of patients diagnosed with conjunctivitis did not receive treatment. However, between baseline and follow-up, cases spent significantly more time on productive activities outside the home potentially showing a positive impact of treatment on livelihood engagement.

IMPACT OF URE ON CHILDREN

To examine the impact of URE on children, we conducted a qualitative study due to low numbers observed in PEC clinics. We conducted in-depth semi-structured interviews with 14 children aged under 18 years and their carers. The children were selected through Kabgayi hospital, for those who had been diagnosed within 6 months. Kabgayi hospital is located in the Southern province, and provides public specialist and general eye health services and is the most common referral centre for children with URE. Key topics covered included child's vision, care seeking for child's vision, challenges before glasses, and key changes since glasses obtained, at home, at school and places of play. Interviews were recorded and conducted in English with Kinyrwan translation (first 5) or in Kinyrwan. Field notes were also made to supplement the transcription of the recordings. Thematic analysis was used to analyse findings.

Key findings from this part of the study include:

- *Impact at school:*

All children mentioned struggling with reading the blackboard prior to glasses, and this alerted teachers to a potential issue with vision. These problems improved after getting glasses and some carers also attributed an improvement in school performance due to the glasses.

- *Impact at home and in the community*

Children in the sample and their caregivers reported difficulties with homework, walking to school, watching television, and other leisure and social activities. After getting glasses, most interviewees noticed improved engagement with reported difficulties.

- *Care seeking*

Caregivers reported difficulties in access, including delayed diagnosis and referral from the health centre, distance to Kabgayi and financial difficulties to raise money for glasses.

Conclusion

Universal access to primary care and integrated primary eye care is a key global initiative to reduce preventable causes of blindness.(18) Yet, scarce resources require careful planning. Our findings support the need to provide access to PEC. Nearly a third of the Rwandan population could benefit from PEC (34%; 95%CI=31.7, 36.3%), mainly driven by ocular symptoms (28%; 95%CI=25.8-30.3%) and a need for reading glasses in those aged 40 years and older (33% of age 40+, 95%CI=29.4, 36.9). Women were more likely to need PEC and require referrals, indicating more serious eye conditions, such as cataract. As women are more likely to be caregivers and stay close to home, when and where PEC is provided must be considered in planning to ensure equity of access.

The population surveyed showed generally high levels of awareness for refractive error, presbyopia and cataract, the most common conditions leading to visual impairment. A high proportion of the population indicated that poor vision is accepted as a feature of old age, indicating that further work to raise awareness of eye health and eye care could benefit the population. There was also a high level of awareness of where to seek eye care, with nearly three quarters of those surveyed indicating attendance at the health centre.

This report has described an integrated PEC model in Rwanda, where the PEC service was embedded within the health-centre activities. This has led to 2,707 nurses trained and PEC provided in every health centre in the country. The contextual factors that have enabled implementation relate to the significant progress in the strengthening of the eye health system and integration of PEC in Rwanda. This highlights the importance of developing PEC within a health system. The competence based training programme and curriculum, together with the clinical resources have led to a consistently trained workforce.

Some areas for improvement include ensuring adequate supply of equipment, protocols and medications for delivery of PEC. Further developments on information flows between primary care, secondary care and tertiary care would provide a more integrated service. The development and sustainability of training and supervision, of both PEC nurses and OCOs, also requires further consideration by the stakeholders in Rwanda.

Overall, we found that people with presbyopia experienced an improvement in the vision-related quality of life and reported significant benefits in social interactions and daily activities that depend on vision once their presbyopia had been treated with ready-made glasses in PEC. But we found no effect on general health related quality of life, time use or PCE after adjusting for age, sex and SES. There are a number of reasons for these findings. Nearly half of participants recruited with presbyopia did not purchase glasses (45.6%) despite similar levels of reported visual function at baseline, which suggests that glasses were not sufficiently valued, where the perceived benefit does not merit the costs. Wealthier people were more likely to purchase glasses, which also indicates that cost is a factor. General health related quality of life tools may be too crude to detect small changes in visual function, and was only detected in VrQoL instruments. In this primarily agrarian society, presbyopic correction may not have lead to greater wealth, though with Rwanda's economic development strategy including a focus on more off-farm jobs and more urbanisation, this effect may change over time.

Recommendations

Based on the findings outlined in this report, we would ask the stakeholders in Rwanda to discuss and consider:

- Maintaining a national PEC programme is maintained to meet the large population need.
- Maintaining and strengthening partnership working between all eye care stakeholders, through the Rwanda Eye Care Technical Working Group, to enable further development of the eye health care system
- Improving co-ordination of patient-centred care across different health facilities
- Developing a sustainable model of training and supervision for PEC nurses and OCOs, to ensure continuity of primary eye care service and assure quality of care.
- Developing health promotion activities to raise awareness of eye health and availability of eye care, and the benefits of presbyopic correction, particularly targeting older people.
- Using Rwanda's experience of PEC to influence development of PEC programmes in other African countries

Parts of this report are published in PLOS One and BMC Health Services Research journals. For a detailed technical report, or a copy of the papers, please contact Dr Jennifer Yip (Jennifer.yip@lshtm.ac.uk)

References

1. Pascolini D, Mariotti SP. Global estimates of visual impairment: 2010. *The British journal of ophthalmology*. 2010;96(5):614-8.
2. Naidoo K, Govender P, Holden B. The uncorrected refractive error challenge. *Community eye health / International Centre for Eye Health*. 2014;27(88):74-5.
3. Sherwin JC, Keeffe JE, Kuper H, Islam FM, Muller A, Mathenge W. Functional presbyopia in a rural Kenyan population: the unmet presbyopic need. *Clin Experiment Ophthalmol*. 2008;36(3):245-51.
4. Senyonjo L, Lindfield R, Mahmoud A, Kimani K, Sanda S, Schmidt E. Ocular morbidity and health seeking behaviour in Kwara state, Nigeria: implications for delivery of eye care services. *PLoS one*. 2014;9(8):e104128.
5. International Agency for Prevention of Blindness. [Available from: www.iapb.org/vision-2020].
6. World Health Organisation. Universal Eye Health: Global Action Plan 2014-2019 [Available from: www.who.int/blindness/actionplan/en/].
7. World Health Organisation. Task-Shifting international guidelines [Available from: www.who.int/workforcealliance/knowledge/resources/taskshifting_guidelines/en/].
8. Mathenge W, Nkurikiye J, Limburg H, Kuper H. Rapid assessment of avoidable blindness in Western Rwanda: blindness in a postconflict setting. *PLoS Med*. 2007;4(7):e217.
9. Sherwin JC, Mathenge W, Hassan K, Cook C, Kalua K, Courtright P, et al. Refractive error blindness in older africans. *Ophthalmology*. 2013;120(7):e40.
10. Courtright P, Murenzi J, Mathenge W, Munana J, Muller A. Reaching rural Africans with eye care services: findings from primary eye care approaches in Rubavu District, Rwanda. *Trop Med Int Health*. 2010;15(6):692-6.
11. Muller A, Murenzi J, Mathenge W, Munana J, Courtright P. Primary eye care in Rwanda: gender of service providers and other factors associated with effective service delivery. *Trop Med Int Health*. 2010;15(5):529-33.
12. Binagwaho A, Scott K, Rosewall T, Mackenzie G, Rehnberg G, Hannema S, et al. Improving eye care in Rwanda. *Bull World Health Organ*. 2015;93(6):429-34.
13. Naidoo KS, Naidoo K, Maharaj Y, Ramson P, Wallace D, Dabideen R. Scaling up the delivery of refractive error services within a district health system: the KwaZulu-Natal, South Africa experience. *BMC Health Serv Res*. 2013;13:361.
14. Danquah L, Kuper H, Eusebio C, Rashid MA, Bowen L, Foster A, et al. The long term impact of cataract surgery on quality of life, activities and poverty: results from a six year longitudinal study in Bangladesh and the Philippines. *PLoS one*. 2014;9(4):e94140.
15. Moore GF, Audrey S, Barker M, Bond L, Bonell C, Hardeman W, et al. Process evaluation of complex interventions: Medical Research Council guidance. *Bmj*. 2015;350:h1258.
16. Rwanda Ministry of Health. [Available from: www.moh.gov.rw/index.php?id=2].
17. Courtright P, Seneadza A, Mathenge W, Elish E, Lewallen S. Primary eye care in sub-Saharan African: do we have the evidence needed to scale up training and service delivery? *Ann Trop Med Parasitol*. 2010;104(5):361-7.
18. World Health Organization. Universal eye health: A global action plan 2014-2019 2013 [Available from: www.who.int/blindness/actionplan/en/].

Appendices

Appendix 1: The Rwanda Primary Eye Care Process Evaluation Group (alphabetical order)	
<i>Theophile Dushime</i>	Rwanda Ministry of Health
<i>Hannah Faal</i>	Independent evaluator
<i>Sebastian Ford</i>	Vision for a Nation Foundation
<i>Wanjiku Mathenge</i>	Rwanda International Institute of Ophthalmology and Dr Agarwal's Eye Hospital, Kigali, Rwanda
<i>Marie-Aimee Muhimpundu</i>	Rwanda Biomedical Centre, Rwanda Ministry of Health
<i>David Musendo</i>	Lifetime Consulting and Partners Ltd
<i>Eliana Ndererimana</i>	Fred Hollows Foundation
<i>John Nkurikiye</i>	Rwanda ophthalmology Society, Rwanda International Institute of Ophthalmology and Dr Agarwal's Eye Hospital, Kigali, Rwanda
<i>Vincent Tuzinde</i>	Onesight
<i>Pacifique Uwamahoro</i>	Vision for a Nation Foundation
<i>Abdallah Uwihoreye</i>	Vision for a Nation Foundation
<i>Jennifer L Y Yip</i>	International Centre for Eye Health, London School of Hygiene & Tropical Medicine

Appendix 2: Analytical Framework and Methodological Source of Data		
Domain	Element or indicator for analysis	Source of data
CONTEXTUAL FACTORS		
Leadership and governance	Engagement of Ministry of Health and key stakeholders for delivery of PEC	Stakeholder interviews
Healthcare Financing	Funding for PEC delivery Funding for patient access to PEC	Stakeholder documents Rwanda Ministry of Health reports KAP survey
Health workforce	PEC nurses trained PEC nurse supervision	VFAN programme monitoring data Stakeholder interviews Structured observation interviews

Appendix 2 (CONT): Analytical Framework and Methodological Source of Data

Domain	Element or indicator for analysis	Source of data
CONTEXTUAL FACTORS (CONT)		
Medical products, technologies	Availability of equipment (see Appendix 1) Availability of treatment options (antimicrobial and antihistamine eye drops, glasses)	Stakeholder interviews Structured observations RMOH reports VFAN programme documents and data
Information and research	PEC routine monitoring data	RMOH reports VFAN programme documents and data VFAN routine data and data validation study
Service delivery (see implementation below)	Number of PEC nurses per health facility and per population Number of PEC examinations delivered	VFAN programme documents and monitoring data
IMPLEMENTATION		
Fidelity	Number of nurses and OCOs trained	VFAN programme documents
	Adherence to curriculum	Structured observations
Dose	Number of PEC examinations delivered	VFAN programme monitoring data
	Number of glasses, eye drops prescribed and referrals made	VFAN programme monitoring data
Adaptation	Changes to PEC programme	VFAN programme documents Stakeholders interviews
Reach	Geographical spread of services Access by those who need PEC	VFAN programme monitoring data Clinic survey

PEC- primary eye care; RMOH- Rwanda Ministry of Health; KAP- knowledge attitude and practice; VFAN – Vision for a Nation



**London School of Hygiene
& Tropical Medicine**

Keppel Street, London WC1E 7HT
United Kingdom

www.lshtm.ac.uk
