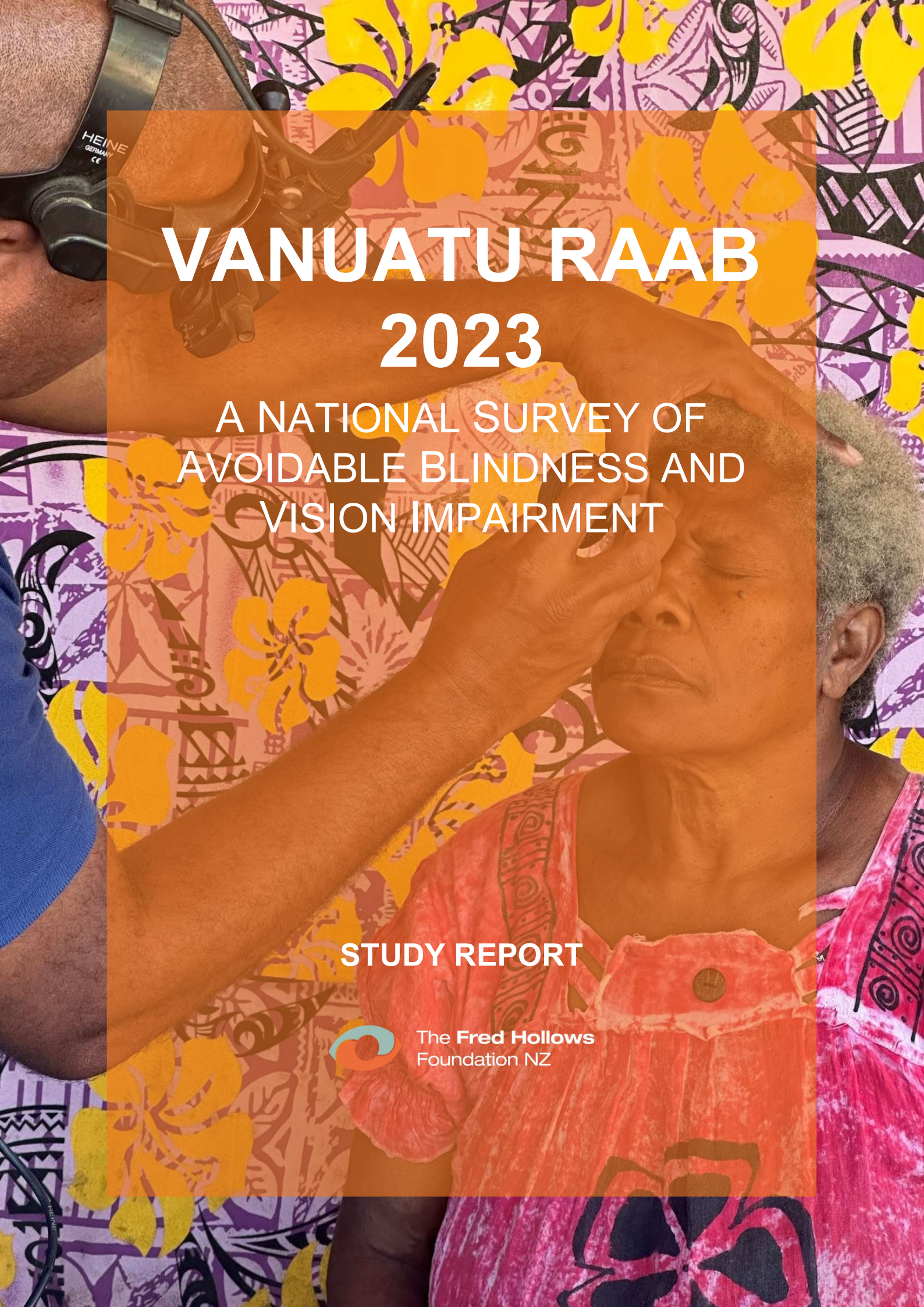

VANUATU RAAB 2023

A NATIONAL SURVEY OF AVOIDABLE BLINDNESS AND VISION IMPAIRMENT

STUDY REPORT

The **Fred Hollows** Foundation NZ

FOREWORD

It is with great pride and anticipation that I introduce the RAAB (Rapid Assessment of Avoidable Blindness) survey report for Vanuatu, a crucial component of The Fred Hollows Foundation NZ's ongoing commitment to improving eye health across the Pacific. Our efforts are deeply rooted in the belief that everyone, regardless of their location or economic status, has the right to good vision.

In February 2023, The Fred Hollows Foundation NZ (The Foundation) commenced the State of Eye Health Research Programme, a collaborative initiative running from January 2023 to December 2027. This programme, involving Pacific Island governments, the New Zealand Government, JN & HB Williams Foundation, The University of Auckland, and Ian Anderson Economics, aims to provide evidence to help Pacific governments develop sustainable eye health plans and policies.

The Pacific faces numerous challenges, including growing and ageing populations, rising non-communicable diseases, socio-economic disparities, and climate change impacts. The goal of the programme is to support Pacific governments in establishing affordable, effective, and equitable eye health systems. Addressing eye health is essential for achieving the Healthy Islands vision, a goal outlined by Pacific Health Ministers that promotes sustainable, inclusive health and wellbeing across Pacific Island nations, and advancing Universal Health Coverage.

The RAAB survey in Vanuatu exemplifies our commitment to reducing avoidable blindness and vision impairment in the Pacific. The findings from this survey will not only inform our work in Vanuatu but also guide targeted interventions and policy recommendations to improve eye health in the country. These efforts will contribute to the broader goals of the State of Eye Health Research Programme.

Addressing avoidable blindness and vision impairment is central to The Foundation’s 2023 - 2032 Strategy. We are committed to ensuring that marginalised and disadvantaged communities remain a focus throughout this research programme. Together, we can make significant strides towards a future where everyone in the Pacific has access to the eye care they need.

I extend my deepest gratitude to all those who have contributed to this survey and to the ongoing efforts of the State of Eye Health Research Programme. Your dedication and collaboration are making a profound difference in the lives of many.

Sincerely,

Dr Audrey Aumua
Chief Executive Officer
The Fred Hollows Foundation NZ

ACKNOWLEDGEMENTS

The Fred Hollows Foundation NZ would like to express our deepest gratitude to all those who contributed to the successful completion of this Rapid Assessment of Avoidable Blindness (RAAB) survey.

Firstly, we extend our sincere thanks to the Vanuatu survey participants for their time and cooperation. Without their willingness to participate, this study would not have been possible.

We also wish to acknowledge the support of local health authorities and community leaders who facilitated our work in the various survey locations. In particular, we are grateful to the Ministry of Health and the Bureau of Statistics of the Government of Vanuatu. Their support and guidance were essential to the success of this project.

We extend our heartfelt thanks to the World Health Organization (WHO) Country Office in Vanuatu for their invaluable support and collaboration, especially in setting up the survey. In particular, we would like to acknowledge Dr Tsogzolmaa Bayandorj, Technical Officer for Noncommunicable Diseases, and Dr Eunyoung Ko, WHO Country Liaison Officer. Their assistance with early coordination and logistics contributed to the successful execution of this project.

We would also like to extend our sincere gratitude to Dr Anasaini Cama, the RAAB Trainer, for her exceptional training and guidance, which were instrumental in the successful execution of this survey.

We are immensely grateful to our dedicated field team, whose hard work and commitment were crucial to the data collection process. Special thanks to Dr Johnson Kasso, the Principal Investigator and the wonderful and dedicated members of the data collection teams he led: Mr Danstan Tate who played a crucial role in coordinating and implementing the RAAB, and (in alphabetical order) Dr Andronico Ly, Dr Duke Mataka, Dr Mundi Qalo, Dr Nola Pikacha, and the eye nurses: David Jimmy, Edwin Namel, Gilles Tavoa, Janrethy Kalpet, Kenneth Kawo, Lui Daniel, Madopule Nanu, Marie-Leah Alguet, Monique Tahi, and Santhy Wilfred. We acknowledge the guidance and expertise of our Technical Advisors, whose insights and advice greatly enhanced the quality of this study and report: the RAAB Team at the International Centre for Eye Health of the London School of Tropical Hygiene and Medicine and at Peek Vision in London, Ms Komal Ram, Ms Moneeta Pal, Ms Quenelda Clegg, Ms Nimisha Chabba, and Dr Iris Wainiqolo. Thank you also to our Advisor and report writer, Dr Fabrizio D'Esposito, for his work.

A heartfelt thanks to The New Zealand Ministry of Foreign Affairs and Trade, JN & HB Williams Foundation, and The Fred Hollows Foundation (Australia) for providing the financial support necessary to undertake this survey.

Thank you to everyone who played a part in this project. Your collective efforts have made this survey a success.

SUGGESTED CITATION

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LIST OF ABBREVIATIONS

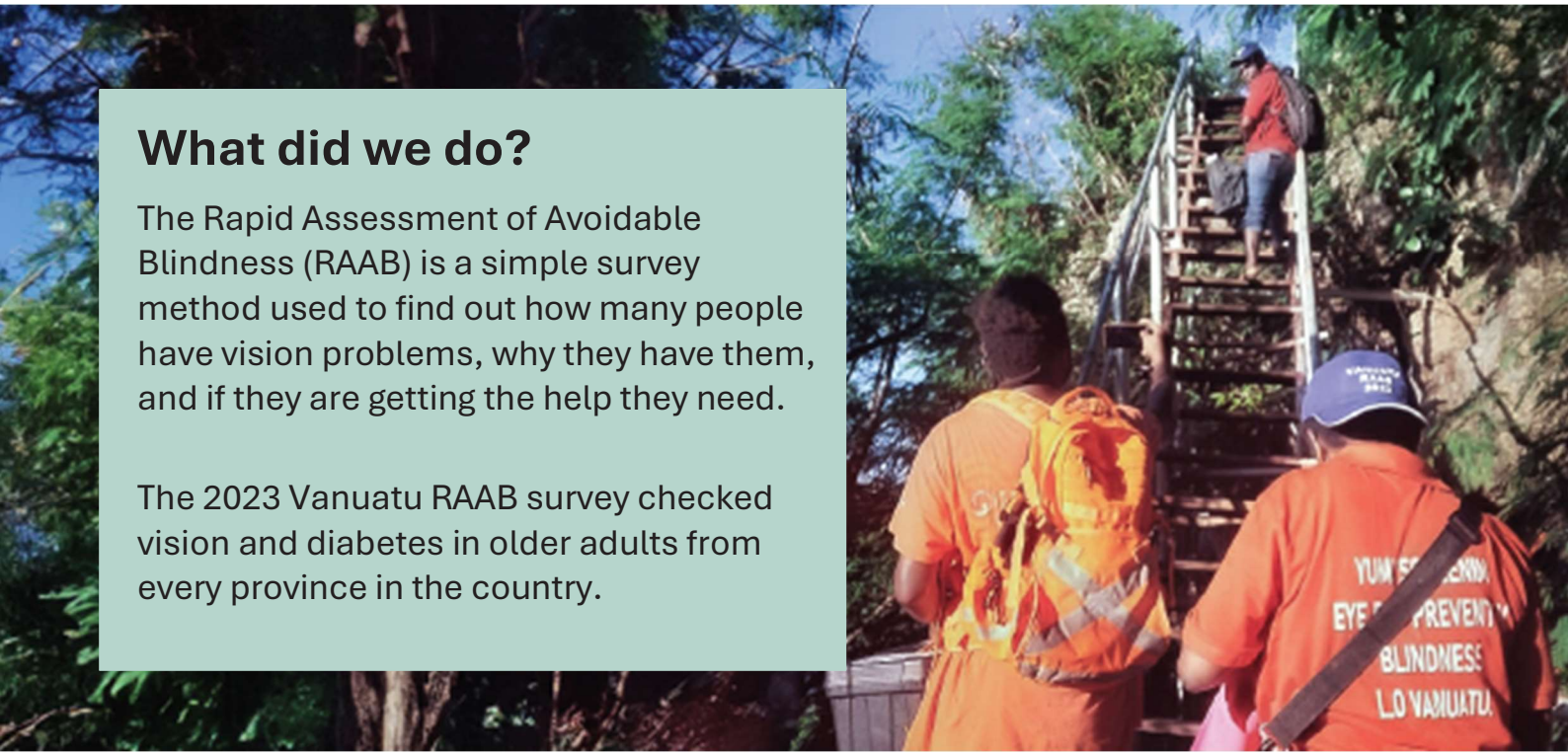
95%CI	95% Confidence Intervals
CNS	Central Nervous System
CSC	Cataract Surgical Coverage
DALYs	Disability-Adjusted Life Years
DR	DR
eCSC	Effective Cataract Surgical Coverage
eREC	Effective Refractive Error Coverage
EVI	Early Vision impairment
EVI+	Early Vision Impairment or worse
HDI	Human Development Index
IAPB	International Agency for the Prevention of Blindness
IPEC	Integrated People-Centred Care
IOL	Intraocular Lens
MVI	Moderate Vision Impairment
MVI+	Moderate Vision Impairment or worse
NCDs	Non-Communicable Diseases
PHC	Primary Health Care
PinVA	Pinhole Visual Acuity
PVA	Presenting Visual Acuity
RAAB	Rapid Assessment of Avoidable Blindness
REC	Refractive Error Coverage
SOPs	Standard Operating Procedures
SVI	Severe Vision Impairment
SVI+	Severe Vision impairment or worse
UCVA	Uncorrected Visual Acuity
VA	Visual Acuity
WHO	World Health Organization

Rapid Assessment of Avoidable Blindness in Vanuatu

August – December 2023

MINISTRY OF HEALTH
GOVERNMENT OF VANUATU

The Fred Hollows Foundation NZ



What did we do?

The Rapid Assessment of Avoidable Blindness (RAAB) is a simple survey method used to find out how many people have vision problems, why they have them, and if they are getting the help they need.

The 2023 Vanuatu RAAB survey checked vision and diabetes in older adults from every province in the country.

How did we do it?

We made a list of all the villages and neighbourhoods in the country with help from local authorities. We randomly picked 142 neighbourhoods and villages, and in each we then randomly picked 40 people who were 50 years old or older. We only chose older adults because most vision problems happen in this age group.

We ended up visiting about 5,000 people all over the country and we looked at their eyes and we asked them questions about their eye health. We also checked if they had diabetes and if it affected their eyes. We had five teams to do this survey, and each team had one eye health specialist and at least one eye health nurse.

What did we learn?

Prevalence of Vision Impairment: One in 10 older people in Vanuatu has serious vision problems that could be prevented.

Avoidable blindness: Nine in 10 older people who are blind in Vanuatu, don't need to be.

Cataracts as the Leading Cause: Cataracts are the main reason for blindness and severe vision problems in Vanuatu.

Uncorrected Refractive Errors: Not wearing the right glasses is the top reason for less severe vision problems in Vanuatu.

Cataract Surgical Coverage (CSC): About eight in 10 people who are blind from cataracts have had surgery, but less than half of those with moderate vision loss have been treated.

Visual Outcomes After Cataract Surgery: Most people see well after cataract surgery but many still ended up with poor vision, also showing room for improvement.

Effective Cataract Surgical Coverage (eCSC): The quality of cataract surgeries in Vanuatu can do with some improvement to help more people see well after surgery.

Distance Refractive Error Coverage: About one in ten older adults in Vanuatu need glasses to see in the distance.

Effective Refractive Error Coverage (eREC): Only one in ten older adults who need glasses to see in the distance are getting glasses that work for them.

Use of reading glasses: Around one in three older adults who need reading glasses in Vanuatu have them.

Prevalence of DR (DR): More than one in 10 people in the survey had suspected or known diabetes. Two in 10 people who had diabetes also had eye problems caused by the disease.

DR Screening: Almost nine in 10 people with diabetes had never had their eyes checked before, showing the need for better eye health services.

Eye Health and Gender: We did not find any big differences between women and men in Vanuatu when it comes to eye health. Still, we think that women in Vanuatu are less likely to have cataract surgery when they need it, and they are also more likely to have eye problems due to diabetes.

What can we do about it?

We should make cataract surgeries better and do more of them: We need to continue to improve how cataract surgeries are done and make sure more people can get them.

We should provide more services for people who need glasses: We need to make sure more people can get affordable glasses and train healthcare workers to find and help people with vision problems.

We should make diabetes care include eye exams: People with diabetes need regular eye checks to prevent vision problems, so we should improve these services in diabetes programs.

We should include eye care in basic health services: Eye care should be part of regular healthcare, and we should train health workers to spot and treat eye problems early.

We should raise awareness about the importance of eye health: We need to educate people about the importance of regular eye exams and the services available.

We should strengthen health systems for eye care: We need to support hospitals and clinics, train more staff, and make sure there are enough supplies to support long-term eye care.

We should push for more support for eye health policies: We need to keep working to make sure eye health is a priority for the government and that enough support is given to eye care programs.

KEY MESSAGES AND RECOMMENDATIONS

Methodology and Participation Rates: The 2023 national Vanuatu Rapid Assessment of Avoidable Blindness (RAAB) survey utilized a cross-sectional population-based design to assess the prevalence and causes of blindness and vision impairment among individuals aged 50 years and older across all six provinces that make up the country. Conducted from August to December 2023, the survey achieved an 87.4% participation rate, with 4,965 out of 5,680 eligible participants examined. The survey employed visual acuity (VA) tests, lens examinations, random blood glucose tests to evaluate diabetes status, and (in-)direct fundus examinations to screen for DR.

Prevalence of Blindness: The age- and sex-adjusted prevalence of blindness with available correction in Vanuatu was 1.7% (95%CI 1.3%-2.0%), with severe vision impairment (SVI), moderate vision impairment (MVI), and early vision impairment (EVI) at 1.7% (95%CI 1.2%-2.2%), 10.0% (95%CI 8.8%-11.1%), and 7.7% (95%CI 6.9%-8.6%), respectively. Although this prevalence is lower in relation to other countries in the Pacific for which comparable data is available, these findings underscore the significant burden of vision impairment in the population aged 50 years and older. It is estimated that there are more than 5,000 people in Vanuatu who have MVI, SVI, or are blind and a further 3,000 who have EVI.

Ninety-two percent of blindness in Vanuatu is avoidable. This means that nine in 10 people who are blind in Vanuatu don't need to be.

Cataracts as the Leading Cause: Cataracts were identified as the leading cause of blindness, SVI, and MVI in Vanuatu, responsible for 82.4%, 91.0%, and 66.0% of cases, respectively. This is consistent with other countries in the region and globally.

Uncorrected Refractive Errors: Uncorrected refractive errors were the leading cause of EVI, responsible for 76.9% of cases. They were also the second leading cause of MVI, highlighting the need for strengthened refractive services. This is also consistent with many other countries in the region and globally.

Cataract Surgical Coverage (CSC): The CSC among people who are blind from cataract in Vanuatu was found to be 79.2% (95%CI 72.1%-86.3%), close to the 80% threshold often discussed in relation to Universal Health Coverage goals. The CSC for individuals with MVI from cataract was 38.9% (95%CI 33.2%-44.7%), which is comparable to the median for the Western Pacific Region. This indicates that less than half of those with MVI who could benefit from cataract surgery are receiving it. In practice this means that there are more than 3,500 people in Vanuatu who are bilaterally blind or have bilateral VA of <3/60 from cataract, and more than 5,000 who have unilateral blindness or have unilateral (one eye) VA of <6/18 from the condition.

Effective Cataract Surgical Coverage (eCSC): The eCSC, which combines coverage and visual outcome following surgery, was 54.6% (95%CI 46.3%-62.9%) among people who are blind and 25.3% (95%CI 20.4%-30.3%) among those with a VA <6/18. The relative quality gaps were 31.1% and 34.9%, respectively. When the quality gap is 25% or greater it is recommended that priority is given to improving quality of cataract surgery and outcomes over increasing outputs.

Visual Outcomes After Cataract Surgery: A good visual outcome (VA ≥6/12) after cataract surgery was achieved in 75.8% and 58.2% of participants with available correction and with pinhole, respectively. On the other hand, 7.2% and 10.4% of surgeries resulted in a poor outcome (VA <6/60), with available correction and with pinhole, respectively. The World Health Organization recommends that no more than 5% of surgeries should result in a VA of <6/60. This highlights the need for enhanced surgical techniques and postoperative care to improve visual outcomes.

Refractive Error and Use of Spectacles: The prevalence of distance refractive errors in the study population was 10.9%, and only 2.7% of participants used distance vision glasses. Anyone aged 50 years and older is presumed to need glasses for reading, but only about one third of participants (33.8%) used them.

Refractive Error Coverage (REC) and Effective Refractive Error Coverage (eREC): Age- and sex-adjusted REC and eREC were 12.6% (95%CI 9.8%-15.3%) and 10.3% (95%CI 7.7%-12.9%), respectively. This suggests that a significant proportion of individuals with refractive errors are not receiving necessary corrective services.

Prevalence of Diabetic Retinopathy (DR): The survey found that 13.3% of participants who consented to take part in the diabetes examination (n=4,937) had known or suspected diabetes. Of these, 88.9% consented to a dilated fundus examination. Among those examined, 74.5% had no retinopathy, while 21.2% (95%CI 17.2%-25.3%) had retinopathy, and 8.0% (95%CI had 5.9%-10.2%) had sight-threatening DR. The prevalence of diabetes found in this study is comparable to that reported in the literature. Prevalence of retinopathy and sight-threatening DR is lower than previously reported in Vanuatu but consistent with global data, likely due to the population-based nature of this study compared with previous studies that focused on registered patients with diabetes.

DR Screening: Almost two-thirds (63.4%) of study participants who had diabetes were aware of their condition. Nonetheless, a significant gap exists in DR screening with 85.9% of study participants with a prior diagnosis of diabetes having never undergone an eye examination for DR. This underscores the need for further strengthening of screening and management services.

Eye health and gender: The study found that the prevalence of blindness and vision impairment was similar between women and men in Vanuatu. However, men appeared to have higher CSC (presenting VA (PVA) 3<60; 82.8% *cf.* 75.0%), while women had better eCSC (PVA <3/60; 58.2% *cf.* 51.6%) and better visual outcomes after surgery (PVA <6/60; 12.8% *cf.* 6.9% and pinhole VA <6/60 9.1% *cf.* 4.6%). Men also appeared to have a higher eREC (13.0%; 95%CI 9.2%-16.8%) compared to women (7.5%; 95%CI 4.2%-10.7%), whilst women had higher rates of retinopathy (24.8% *cf.* 17.3%) and sight-threatening DR (10.4% *cf.* 5.4%) compared with men. These findings highlight the need for targeted interventions to ensure equitable eye health services for both genders.

Thus, it is recommended that the eye health sector in Vanuatu work with all relevant stakeholders to:

Improve Cataract Surgery Outcomes: Prioritise strategies to increase cataract surgery coverage, targeting underserved areas to reach more patients.

Expand Refractive Error Services: Increase access to affordable corrective lenses and enhance training for primary health care providers to improve service delivery.

Enhance Diabetes Care with DR Screening: Integrate regular eye exams into diabetes care programs and strengthen DR screening and treatment protocols.

Integrate Eye Health into Primary Care: Train primary care providers in eye care to ensure timely detection and treatment of conditions, improving accessibility.

Boost Public Awareness: Conduct targeted campaigns to raise awareness of the importance of regular eye exams, especially for those with diabetes.

Invest in Health Systems: Support eye care infrastructure, workforce training, and supply chains for sustainable improvements.

Strengthen Advocacy and Policy: Focus advocacy on prioritizing eye health in national policies and budgets, emphasizing the economic benefits to attract support.

A QUICK REFERENCE GUIDE TO THE KEY INDICATORS IN THE KEY MESSAGES

Indicator	Abbr.	Definition
Visual acuity	VA	The clarity of vision of an individual
Presenting visual acuity	PVA	VA with refraction correction that is available to participant
Blindness	n/a	VA <3/60 in the better eye
Severe vision impairment	SVI	VA <6/60 to 3/60
Moderate vision impairment	MVI	VA <6/18 to 6/60
Early vision impairment	EVI	VA <6/12 to 6/18
Severe vision impairment or worse	SVI+	VA <6/60
Moderate vision impairment or worse	MVI+	VA <6/18
Early vision impairment or worse	EVI+	VA <6/12
Cataract surgical coverage	CSC	[(x+y)/(x+y+z)]*100 Where: x = individuals with unilateral pseudo/aphakia (i.e. operated cataract) and operable cataract in the other eye; y = individuals with bilateral pseudo/aphakia, regardless of VA; z = individuals with bilateral operable cataract.
Effective cataract surgical coverage	eCSC	[(a+b)/(x+y+z)]*100 Where: a = individuals with unilateral pseudo/aphakia achieving PVA of 6/18 or better in the operated eye and operable cataract in the other eye; b = individuals with bilateral pseudo/aphakia achieving PVA of 6/18 or better in at least one eye; x, y and z as above for CSC.
Refractive error coverage	REC	[(a+b+c)/(a+b+c+d)]*100 Where *a* = individuals with UCVA <6/12 in the better eye who present with spectacles or contact lenses for distance vision and whose PVA is ≥6/12 in the better eye (met need); *b* = individuals with a history of refractive surgery whose UCVA is ≥6/12 in the better eye (met need); *c*=individuals with UCVA <6/12 in the better eye who present with spectacles or contact lenses for distance vision and have PVA <6/12 in the better eye, but who improve to ≥6/12 on pinhole or refraction (undermet need) *d*=individuals with UCVA <6/12 in the better eye who do not have distance vision correction and who improve to ≥6/12 on pinhole or refraction (unmet need)
Effective refractive error coverage	eREC	[(a+b)/(a+b+c+d)]*100 Where *a* = individuals with UCVA <6/12 in the better eye who present with spectacles or contact lenses for distance vision and whose PVA is ≥6/12 in the better eye (met need); *b* = individuals with a history of refractive surgery whose UCVA is ≥6/12 in the better eye (met need); *c*=individuals with UCVA <6/12 in the better eye who present with spectacles or contact lenses for distance vision and have PVA <6/12 in the better eye, but who improve to ≥6/12 on pinhole or refraction (undermet need) *d*=individuals with UCVA <6/12 in the better eye who do not have distance vision correction and who improve to ≥6/12 on pinhole or refraction (unmet need)
Diabetic Retinopathy (*Assessed using the Scottish DR Grading Scheme*)	DR	R0 (No DR): No visible signs of DR. R1 (Background DR): Presence of microaneurysms, retinal haemorrhages, and/or hard exudates, but no signs of more severe DR. R2 (Pre-proliferative DR): Presence of venous beading, venous loop, IRMA (intraretinal microvascular abnormalities), multiple deep/dark blot haemorrhages. R3 (Proliferative DR): New vessels on the disc (NVD) or elsewhere (NVE), preretinal or vitreous haemorrhage, fibrovascular proliferation, or tractional retinal detachment. M0 (No maculopathy): No signs of maculopathy. M1 (Maculopathy): Presence of exudate within 1 disc diameter of the fovea, or group of exudates in the macula, or any microaneurysm or haemorrhage within 1 disc diameter of the fovea, associated with a best VA of ≤6/12. P (Photocoagulation scars): Evidence of photocoagulation treatment for proliferative or severe non-proliferative retinopathy. Referable DR: Defined as R2 (Pre-proliferative DR) or R3 (Proliferative DR). Referable Maculopathy: Defined as M1 (Maculopathy).

EXECUTIVE SUMMARY

Background

The 2023 Vanuatu RAAB (Rapid Assessment of Avoidable Blindness) survey, conducted by The Fred Hollows Foundation NZ and the Ministry of Health of the Government of Vanuatu, represents a significant effort to understand the prevalence and causes of blindness and vision impairment among people aged 50 years and older in Vanuatu. This survey forms part of a broader initiative aimed at enhancing eye health across the Pacific, driven by the belief that everyone has the right to good vision, irrespective of their geographic or economic circumstances.

Objectives

The primary aim of this study was to determine the prevalence and causes of blindness and vision impairment among people aged 50 years and older in Vanuatu. A secondary aim of this study was to determine the prevalence of diabetic retinopathy (DR) among the same population.

The study objectives were to determine:

- Prevalence of blindness, severe, moderate, and early vision impairment
- Proportion of blindness, severe, moderate, and early vision impairment that is avoidable
- Main causes of blindness, severe, moderate, and early vision impairment
- Cataract surgical coverage (CSC) and effective cataract surgical coverage (eCSC)
- Vision outcomes following cataract surgery
- Barriers to receiving cataract surgery
- Cataract surgery indicators: place, type, and cost
- Prevalence of uncorrected refractive errors
- Effective refractive error coverage (eREC)
- Prevalence of diabetes
- Prevalence of DR

Methods

This cross-sectional population-based survey was carried out across all six provinces of Vanuatu, using the well-established RAAB methodology. A total of 5,680 individuals aged 50 years and older were included in the survey, with 4,965 participants successfully examined. Data collection was conducted from August to December 2023, using a combination of visual acuity (VA) testing, lens examination, and random blood glucose testing to assess diabetes status. Participants identified as having diabetes underwent a dilated fundus examination to screen for DR.

Key Findings

Prevalence of Blindness: The age- and sex-adjusted prevalence of blindness with available correction was 1.7% (95%CI 1.3%-2.0%), with severe vision impairment (SVI), moderate vision impairment (MVI), and early vision impairment (EVI) at 1.7% (95%CI 1.2%-2.2%), 10.0% (95%CI 8.8%-11.1%), and 7.7% (95%CI 6.9%-8.6%), respectively. Although this prevalence is lower in relation to other countries in the Pacific for which comparable data is available, these findings underscore the significant burden of vision impairment in the population aged 50 years and older. It is estimated that there are more than 5,000 people in Vanuatu who have MVI, SVI, or are blind and a further 3,000 who have EVI.

Ninety-two percent of blindness in Vanuatu is avoidable. This means that nine in 10 people who are blind in Vanuatu don't need to be.

Cataracts as the Leading Cause: Cataracts were identified as the leading cause of blindness, SVI, and MVI, responsible for 82.4%, 91.0%, and 66.0% of cases, respectively. This is consistent with other countries in the region and globally.

Cataract Surgical Coverage: The CSC among people who are blind was found to be 79.2% (95%CI 72.1%-86.3%), close to the 80% threshold often discussed in relation to Universal Health Coverage goals. The CSC for individuals with a vision impairment threshold of <6/18 was 38.9% (95%CI 33.2%-44.7%), which is comparable to the median for the Western Pacific Region. This indicates that less than half of those who could benefit from cataract surgery at this level of vision impairment are receiving it. In practice this means that there are more than 3,500 people in Vanuatu who are bilaterally blind or

have bilateral VA of <3/60 from cataract, and more than 5,000 who have unilateral blindness or have unilateral VA of <6/18 from the condition.

Effective Cataract Surgical Coverage: The eCSC, which combines coverage and visual outcome following surgery, was 54.6% (95%CI 46.3%-62.9%) among people who are blind and 25.3% (95%CI 20.4%-30.3%) among those with a vision impairment threshold of <6/18. The relative quality gaps between eCSC and CSC for the two cataract surgical thresholds were 31.1% and 34.9%, respectively. When the quality gap is 25% or greater it is recommended that priority is given to improving quality of cataract surgery and outcomes over increasing outputs.

Visual Outcomes After Cataract Surgery: A good visual outcome (VA ≥6/12) after cataract surgery was achieved in 75.8% and 58.2% of participants with available correction and with pinhole, respectively. On the other hand, 7.2% and 10.4% of surgeries resulted in a poor outcome (VA <6/60), with available correction and with pinhole, respectively. The World Health Organization recommends that no more than 5% of surgeries should result in a VA of <6/60. This highlights the need for enhanced surgical techniques and postoperative care to improve visual outcomes.

Refractive Error: The age- and sex-adjusted prevalence of refractive errors was 8.7%, and 63.5% of people aged 50 years and older who had a refractive error did not have glasses. About one third of participants (33.8%) used near vision spectacles, and only 2.7% used distance vision spectacles.

Refractive Error Coverage and Effective Refractive Error Coverage: Age- and sex-adjusted REC and eREC were 12.6% (95%CI 9.8%-15.3%) and 10.3% (95%CI 7.7%-12.9%), respectively. This suggests that a significant proportion of individuals with refractive errors are not receiving necessary corrective services.

Prevalence of DR (DR): The survey found that 13.3% of participants who consented to take part in the diabetes examination had known or suspected diabetes, with 88.9% consenting to a dilated fundus examination. Among these, 74.5% had no retinopathy, while 21.2% (95%CI 17.2%-25.3%) had retinopathy, and 8.0% (95%CI had 5.9%-10.2%) had sight-threatening DR (i.e. proliferative retinopathy and/or referable maculopathy). The prevalence of diabetes found in this study is comparable to that reported in the literature. The prevalence of any retinopathy and sight-threatening DR is lower than previously reported for Vanuatu, however it is consistent with global evidence and may reflect the fact that this is a population-based study (compared to previous studies that recruited registered people with diabetes who likely had a longer duration of diabetes compared to the RAAB participants).

DR Screening: Almost two-thirds (63.4%) of study participants who had diabetes were aware of their condition. Nonetheless, a significant gap exists in DR screening, with 85.9% of participants with a prior diagnosis of diabetes having never undergone an eye examination for DR. This underscores the need for further strengthening of screening and management services.

Eye health and gender: The study found that the prevalence of blindness and vision impairment was similar between men and women in Vanuatu. However, men appeared to have higher CSC, with 82.8% compared to 75.0% for women. In contrast, women appeared to have better eCSC (PVA <3/60; 58.2% *cf.* 51.6%) and visual outcomes, with fewer cases of poor VA after surgery compared with men (PVA <6/60; 12.8% *cf.* 6.9% and PinVA <6/60 9.1% *cf.* 4.6%). Finally, women had higher rates of retinopathy (24.8%) and sight-threatening DR (10.4%) compared with men (17.3% and 5.4%, respectively). These findings highlight the need for targeted interventions to ensure equitable eye health services for both genders.

Discussion

The 2023 Vanuatu RAAB survey offers a detailed analysis of the current state of eye health in Vanuatu, highlighting significant achievements and areas needing improvement.

The age- and sex-adjusted prevalence of blindness among adults aged 50 years and older was found to be 1.7%. This rate, while still a concern, is lower than in some neighbouring Pacific Island Countries, such as Papua New Guinea (5.6%) and Fiji (2.6%).

Ninety-two percent of blindness was avoidable, meaning that nine in 10 people who are blind in Vanuatu do not need to be.

The survey identified cataract as the leading cause of blindness, SVI, and MVI in Vanuatu. Uncorrected refractive errors were the leading cause of EVI and the second-leading cause of MVI. This is consistent with findings from elsewhere in the region and globally.

The CSC among people who are blind was found to be 79.2%, close to the 80% threshold often discussed in Universal Health Coverage goals. The CSC for individuals with a vision impairment threshold of <6/18 was 38.9% (95%CI 33.2%-44.7%), which is comparable to the median for the Western Pacific Region. The high proportion of individuals citing not feeling a need for surgery, lack of awareness, or fear as reasons for not seeking treatment highlights the need for targeted health education, while challenges related to cost and access point to issues of affordability and availability of services that must be addressed to improve uptake.

The eCSC, which combines coverage and outcome, was 54.6% (95%CI 46.3%-62.9%) among people who are blind and 25.3% (95%CI 20.4%-30.3%) among those with a vision impairment threshold of <6/18. The relative quality gaps were 31.1% and 34.9%, respectively. It is generally accepted that that countries with a quality gap of 25% or higher should invest in quality improvement initiatives before focusing on actions to increase access or output. This suggests that while many cataract surgeries are performed, the quality of surgery and visual outcomes in Vanuatu need improvement. Indeed, a good visual outcome (VA ≥6/12) after cataract surgery was achieved in 75.8% and 58.2% of participants with available correction and with pinhole, respectively. On the other hand, 7.2% and 10.4% of surgeries resulted in a poor outcome (VA <6/60), with available correction and with pinhole, respectively. The WHO recommends that no more than 5% of surgeries should result in a PVA <6/60, which is defined as a poor outcome.

Uncorrected refractive errors were identified as a major cause of vision impairment, affecting a significant portion of the population aged 50 years and older. The eREC was found to be 10.3%. This low coverage shows that many individuals with refractive errors lack necessary corrective services. Although eREC data from the Western Pacific Region is limited, global estimates for those aged 50 years and older in lower-middle-income countries suggest a 13.6% coverage, slightly higher than that found in Vanuatu.

The eCSC and eREC indicators aim to ensure effective vision improvement, particularly in underserved areas, with WHO setting targets for a 30% increase in eCSC and a 40% increase in eREC by 2030 from baseline. Achieving these targets is essential to make the much-needed progress towards the broader goal of Universal Health Coverage.

Diabetes and DR emerged as significant public health issues, with 13.3% of participants identified as having known or suspected diabetes. Among these, 21.2% (95%CI 17.2%-25.3%) had some form of retinopathy, and 8.0% (95%CI 5.9%-10.2%) had sight-threatening DR (i.e. proliferative retinopathy and/or referable maculopathy). Notably, more than eight in 10 people (85.9%) with diabetes had never undergone an eye examination for DR. This lack of regular screening increases the risk of vision loss among individuals with diabetes and underscores the need for further strengthening of screening and management services. Understanding the reasons behind the low screening rate is crucial for effective intervention. Integrating diabetes care with eye health services is also essential to provide comprehensive care, including regular eye examinations and timely treatment for DR.

The study findings suggest that while the overall prevalence of eye conditions may be similar, disparities exist in access to treatment and surgical outcomes between women and men, indicating the need for targeted interventions to ensure equitable eye health services for both genders.

Finally, Conducting the RAAB survey in Vanuatu has greatly strengthened local research capacity. It provided hands-on experience for local health workers and researchers in population-based studies, improving their ability to analyse data and understand vision impairment trends. This experience has equipped them to make evidence-based decisions and implement targeted eye health programs, while fostering a sense of ownership and empowerment for future health initiatives.

Conclusions

The 2023 Vanuatu RAAB survey provides critical insights into the prevalence and causes of blindness and vision impairment in Vanuatu. The findings indicate a relatively low prevalence of blindness but highlight significant gaps in cataract surgical outcomes and coverage, as well as low refractive error coverage. These gaps point to the need for enhanced strategies to improve access to and quality of eye care services. The high prevalence of diabetes and low screening rates for DR also emphasize the urgent need for strengthen integrated diabetes and eye care services.

Recommendations

To address the findings of this survey, it is recommended that the eye health sector in Vanuatu work with all relevant stakeholders to:

1. **Improve Cataract Surgery Outcomes and Increase Cataract Surgical Coverage**

Enhancing surgical techniques and postoperative care to improve the eCSC should be a priority. Efforts should also be made to increase the number of cataract surgeries performed, particularly targeting underserved populations. Outreach programs and mobile surgical units could help reach remote areas.

2. **Expand Refractive Error Services**

Strengthening the provision of refractive error services, including the availability of affordable corrective lenses, can help address the high prevalence of uncorrected refractive errors. Training primary health care providers to identify and manage refractive errors can increase coverage and effectiveness.

3. **Continue to Enhance Diabetes Management and DR Screening**

Improving diabetes care programs to include regular eye examinations is crucial. Strengthening systematic DR screening and treatment protocols within diabetes management programs can help prevent vision loss among people with diabetes.

4. **Integrate Eye Health into Primary Care**

Implementing integrated people-centred eye care as recommended by the World Health Organization (WHO) and the International Agency for the Prevention of Blindness (IAPB) can ensure that eye health services are accessible, affordable, and equitable. Training for primary healthcare workers in eye care can enhance early detection and treatment of eye conditions. Strengthening of primary care system, to ensure that people seeking help have access to eye services.

5. **Continue to Invest in Public Awareness and Health Promotion**

Conducting public health campaigns to raise awareness about the importance of eye health, the availability of services, and the need for regular eye examinations, particularly for those with diabetes, can help increase the uptake of eye care services.

6. **Strengthen Health Systems**

Building the capacity of health systems to support eye care services, including infrastructure, human resources, and supply chains, is essential for sustainable improvements. Ensuring that eye health is integrated into national health plans and budgets is also critical.

7. **Continue to Invest in Policy and Advocacy Initiatives**

Advocacy efforts should continue to focus on ensuring that eye health is a priority in national health policies and budgets, with adequate funding allocated to support comprehensive eye care programs. Emphasizing the economic and social benefits of investing in eye health services can help garner support from policymakers and international donors.

By addressing these key areas, Vanuatu can make significant strides toward reducing the burden of avoidable blindness and vision impairment, ultimately improving the quality of life for its population.

BACKGROUND

Blindness and vision impairment around the world and in the Western Pacific Region

Globally, at least 2.2 billion people are blind or visually impaired, and of these at least one billion have blindness or vision impairment that could have been prevented or could be treated. [1] This figure is expected to increase in coming years due to ageing populations, lifestyle changes, and population growth.

The individual, social, and economic impacts of blindness and vision impairment are devastating and wide-ranging. Vision loss can affect one's quality of life, independence, and mobility and has been linked to falls, injuries, and worsened status in domains spanning mental health, cognition, social function, employment, and educational attainment. Although confounding factors likely contribute to some of the harms that have been associated with vision impairment, testimony from visually impaired persons speaks to the significant role that vision plays in health, vocation, and social well-being. [2] In addition, people with disabilities such as vision loss can suffer discrimination, further increasing the risk of psychological and emotional stress. [2] Recent global productivity losses due to vision impairment are estimated to be US$411 billion annually. [3]

Low- and middle-income countries experience approximately 90% of the burden of vision loss globally. [4] According to the World Health Organization (WHO), these countries bear the highest rates of blindness and vision impairment due to factors like limited access to eye care services, higher prevalence of untreated conditions, and inadequate healthcare infrastructure. [1] The WHO also estimates that over 90 million people experience vision loss in the Western Pacific Region, including 10 million who are blind. [5] Vision loss in Pacific Island Countries is a significant public health issue, with high rates of blindness and vision impairment largely due to common conditions such as cataracts, refractive errors, and DR (DR), and due to limited access to eye care services. [6]

Without effective and urgent action, vision loss has the potential to overwhelm already strained health systems, with devastating economic and social impacts.

A word on Diabetic Retinopathy

Diabetic Retinopathy (DR) is a complication of diabetes that damages the blood vessels in the retina, and which can lead to blindness if not adequately managed. In Pacific Island Countries, diabetes poses a significant health burden, with high prevalence rates exacerbating the risk of DR.[7]

No recent, comprehensive data on blindness and vision impairment is available in Vanuatu

The Republic of Vanuatu comprises a chain of 83 rugged, mountainous volcanic islands, of which 63 are inhabited. The country is divided into six provinces: Malampa, Penama, Sanma, Shefa, Tafea, and Torba. Despite having a relatively low unemployment rate and lower middle-income status, the country has pockets of severe poverty. This is reflected in its low Human Development Index (HDI) and a HDI ranking of 140 out of 192 countries.[8]

Approximately three-quarters of the approximately 300,000-strong population live in rural areas, although internal migration has seen the size of urbanized areas swell over time and the distinction between urban and rural areas is becoming increasingly fluid. [9] Like other countries around the world, Vanuatu is undergoing important demographic changes. The country is witnessing decreasing mortality rates and increasing life expectancy, with the associated increase in the elderly population. The average life expectancy increased from 63.9 years in 2000 to 66.3 years in 2021. [10]

The last population-based survey of blindness and vision impairment in Vanuatu was conducted in 1992.[11] This was a national study of 3,520 Ni-Vanuatu aged six years and older. The survey found that the overall prevalence of bilateral blindness was 0.4% with increasing prevalence among older age groups; cataract caused 85% blindness. Monocular blindness was more common (1.6%), with cataracts again being the leading cause (61%). More recently, the 2020 Vanuatu National Population and Housing Census reported that 1.5% of the population indicated that they had a severe or total visual disability. [9]

The 2020 census also revealed that 14.7% of the population reported a disability, regardless of severity. had a disability; the most commonly mentioned disability was difficulties with seeing (21,124 people). [9]

Non-communicable diseases (NCDs) accounted for an estimated two-thirds (67.3%) of all deaths in 2021 in Vanuatu. In the same year, diabetes accounted for 62.0% of disability adjusted life years (DALYs) in the country. [12] The 2013 Vanuatu STEPS Report estimated a diabetes prevalence of 21.2% among adults aged 25 to 64 years and 31.5% among those aged 55 to 64 years [13] There is also evidence that complications of diabetes are common among those affected, with a study finding that 51% of people with diabetes in Vanuatu had microalbuminuria, 42% had DR, 19% had abnormal foot sensation, and 11% lived with a diabetes-related amputation. [7] This high incidence of diabetes and its complications not only reduces the quality of life for individuals, but also imposes considerable economic and healthcare challenges on these nations. [2, 3]

No comprehensive, population-based, national surveys of blindness and vision impairment have been conducted in Vanuatu since 1992. However, the observed and forecasted demographic changes are expected to cause an increase in the number of new patients with vision impairment and eye health problems, including cataract and posterior segment diseases. With economic growth, the demand for high quality eye health services – including for cataract surgery at earlier stages of the disease – in the public will also increase.

Up-to-date evidence is needed to assess the prevalence of blindness and vision impairment in Vanuatu, to gain insights about how eye care services are responding to the anticipated increase in demand, and to inform the efforts in country going forward.

AIMS & OBJECTIVES

The primary aim of this study was to determine the prevalence and causes of blindness and vision impairment among people aged 50 years and older in Vanuatu. A secondary aim of this study was to determine the prevalence of DR among people with known or suspected diabetes in the same population. The study objectives were to determine:

- Prevalence of blindness, severe, moderate, and early vision impairment
- Proportion of blindness, severe, moderate, and early vision impairment that is avoidable
- Main causes of blindness, severe, moderate, and early vision impairment
- Cataract surgical coverage (CSC) and effective cataract surgical coverage (eCSC)
- Vision outcomes following cataract surgery
- Barriers to receiving cataract surgery
- Cataract surgery indicators: place and type
- Prevalence of uncorrected refractive errors
- Effective refractive error coverage (eREC)
- Prevalence of diabetes[i]
- Prevalence of DR

[i] The test used to assess prevalence of diabetes among individuals without a prior diagnosis of diabetes may result in over-estimates of suspected diabetes in RAAB surveys.

METHODS

Study design

This was a cross-sectional population-based survey completed in all six provinces of Vanuatu. The study used the well-established Rapid Assessment of Avoidable Blindness (RAAB) survey methodology. [14, 15]

The study population was adults living in Vanuatu who were aged 50 years and older at the time of data collection.

Participants and recruitment

Sample Size

The total population in Vanuatu was estimated to be 300,019 in 2020 (151,597 men and 148,422 women). The population aged 50 years and older was estimated at 38,392 (18,235 women and 20,157 men). The proportion of people aged 50 years and older in the country was therefore 12.8%. This data was kindly provided by the Vanuatu Bureau of Statistics.

The required sample size was determined to be 5,680 people, distributed across 142 geographical clusters of 40 residents aged 50 years and older each. This sample was determined to have sufficient statistical power to measure an assumed national prevalence of blindness of 2.33%, with an accuracy of ±20%, a compliance of at least 90%, and a probability of 95% or more. The RAAB7 software was used for the sample size calculations. This sample size and number of clusters was considered logistically achievable despite the large distances and often difficult roads.

Recruitment Approach

The sampling frame was a 2020 list of all enumeration areas in Vanuatu, which was kindly provided by the Bureau of Statistics of the Government of Vanuatu. This list included villages, towns, and cities, along with the size of the population in each settlement. The list of selected enumeration areas is shown in Appendix 1.

One hundred and forty-two enumeration areas (clusters) were randomly selected using a probability proportional to size approach based on the settlement's population size. Given that 12.8% of the population were estimated to be aged 50 years and older, a settlement with a total population of approximately 313 people was expected to include approximately 40 people aged 50 years and older. If settlements larger than 313 people were selected, these were then subdivided into smaller segments of approximately 313 people each. A sub-segment was then randomly selected as the starting point for data collection in that cluster.

Four survey teams accompanied by a local guide visited all households in the selected clusters door-to-door until 40 people aged 50 years and older were identified. The purposes of the study and examination procedures were explained to the subjects and informed consent was sought before data collection (more on this can be found in the relevant section of this report).

The eligibility criteria for a RAAB survey are age (50 years and older), residence (must have lived in the survey area for at least six months), and consent (must provide informed consent). In cases where an eligible person lived in one of the visited households but was not present at the time of data collection, the survey team returned to their household once again on the same day to examine them. If they still could not be examined, information about their visual status was collected from relatives or neighbours. If the data collection team visited all households in a cluster, but failed to identify 40 eligible residents, then the team continued recruitment in the next closest cluster.

Data collection

The field work was conducted between August and December 2023.

Key definitions

We will refer to key indicators of eye health throughout the remainder of this report. In Table 1, on the following page, we provide a list of abbreviations as well as the definitions of key indicators used.

Table 1. List of key definitions and abbreviations

Indicator	Abbreviation	Definition
Visual acuity	VA	The clarity of vision of an individual
Uncorrected visual acuity	UCVA	
Pinhole visual acuity	PinVA	VA with best available refraction correction – for the purpose of this study, this is pinhole vision
Presenting visual acuity	PVA	VA with refraction correction that is available to participant
Blindness	n/a	VA <3/60 in the better eye
Severe vision impairment	SVI	VA <6/60 to 3/60
Moderate vision impairment	MVI	VA <6/18 to 6/60
Early vision impairment	EVI	VA <6/12 to 6/18
Severe vision impairment or worse	SVI+	VA <6/60
Moderate vision impairment or worse	MVI+	VA <6/18
Early vision impairment or worse	EVI+	VA <6/12
Bilateral		This refers to vision impairment in both eyes
Unilateral		This refers to vision impairment in one eye
Cataract surgical coverage	CSC	[(x+y)/(x+y+z)]*100 Where: x = individuals with unilateral pseudo/aphakia (i.e. operated cataract) and operable cataract in the other eye; y = individuals with bilateral pseudo/aphakia, regardless of VA; z = individuals with bilateral operable cataract.
Effective cataract surgical coverage	eCSC	[(a+b)/(x+y+z)]*100 Where: a = individuals with unilateral pseudo/aphakia achieving PVA of 6/18 or better in the operated eye and operable cataract in the other eye; b = individuals with bilateral pseudo/aphakia achieving PVA of 6/18 or better in at least one eye; x, y and z as above for CSC.
Refractive error coverage	REC	[(a+b+c)/(a+b+c+d)]*100 Where *a* = individuals with UCVA <6/12 in the better eye who present with spectacles or contact lenses for distance vision and whose PVA is ≥6/12 in the better eye (met need); *b* = individuals with a history of refractive surgery whose UCVA is ≥6/12 in the better eye (met need); *c*=individuals with UCVA <6/12 in the better eye who present with spectacles or contact lenses for distance vision and have PVA <6/12 in the better eye, but who improve to ≥6/12 on pinhole or refraction (undermet need) *d*=individuals with UCVA <6/12 in the better eye who do not have distance vision correction and who improve to ≥6/12 on pinhole or refraction (unmet need)

Indicator (Continued)	Abbreviation	Definition	
Effective refractive error coverage	eREC	[(a+b)/(a+b+c+d)]*100 Where *a* = individuals with UCVA <6/12 in the better eye who present with spectacles or contact lenses for distance vision and whose PVA is ≥6/12 in the better eye (met need); *b* = individuals with a history of refractive surgery whose UCVA is ≥6/12 in the better eye (met need); *c*=individuals with UCVA <6/12 in the better eye who present with spectacles or contact lenses for distance vision and have PVA <6/12 in the better eye, but who improve to ≥6/12 on pinhole or refraction (undermet need) *d*=individuals with UCVA <6/12 in the better eye who do not have distance vision correction and who improve to ≥6/12 on pinhole or refraction (unmet need)	
Diabetic Retinopathy*	DR	R0 (No DR)	No visible signs of DR.
		R1 (Background DR)	Presence of microaneurysms, retinal haemorrhages, and/or hard exudates, but no signs of more severe DR.
		R2 (Pre-proliferative DR)	Presence of venous beading, venous loop, IRMA (intraretinal microvascular abnormalities), multiple deep/dark blot haemorrhages.
		R3 (Proliferative DR)	New vessels on the disc (NVD) or elsewhere (NVE), preretinal or vitreous haemorrhage, fibrovascular proliferation, or tractional retinal detachment.
		M0 (No maculopathy)	No signs of maculopathy.
		M1 (Maculopathy)	Presence of exudate within 1 disc diameter of the fovea, or group of exudates in the macula, or any microaneurysm or haemorrhage within 1 disc diameter of the fovea, associated with a best VA of ≤6/12.
		P (Photocoagulation scars)	Evidence of photocoagulation treatment for proliferative or severe non-proliferative retinopathy.
		Referable DR	Defined as R2 (Pre-proliferative DR) or R3 (Proliferative DR).
		Referable Maculopathy	Defined as M1 (Maculopathy).

*Scottish DR Grading Scheme

Training of data collectors

Five experienced ophthalmologists and nine ophthalmic nurses were trained for five days prior to data collection. The training covered the RAAB principles, the survey and the eye examination protocol, and data entry into the RAAB7 data management system.

In order to measure inter-observer agreement, each of the teams examined 50 people. Measurements for VA, lens examination results, and cause of blindness for each patient were compared between team members and the team leader. Results were compared between the teams to ensure that they were of an acceptable standard (i.e., kappa ≥0.60). Team leaders were also asked to grade 40 retinal images for the presence of DR using the Scottish DR Grading Scheme and their gradings were assessed for accuracy against grading done by retinal specialists.

Up to four teams made up of one ophthalmologist and two ophthalmic nurses carried out data collection at any one time. Each team was accompanied by a field supervisor at least one day per week.

Examination procedure

All participants were interviewed on whether they experienced any problems with their eyes and whether they owned glasses.

VA was then checked using *Peek Acuity*, a validated mobile tablet-based VA test, or two simplified tumbling 'E' charts. VA was checked placing the tablet or 'E' charts three meters away from the participants. First, UCVA was checked in broad daylight. CVA and PinVA were then checked using a pinhole if participants had a UCVA and/or CVA of <6/12. PVA is calculated from the combined UCVA and CVA data available and used in subsequent logic skips as per previous versions of RAAB.

All participants were directed into a shaded area or indoors for lens examination using a light torch.

If PinVA was <6/12 and no lens opacity was observed, the participants' pupils were dilated with tropicamide 0.5% solution, and indirect ophthalmoscopy was performed to determine the cause of reduced vision for each eye.

The overall primary cause of VA <6/12 was determined to be the cause that was most easily treatable. For example, if one eye had vision impairment due to refractive error, while the other had reduced VA due to significant cataract, refractive error was chosen to be the overall primary cause.

The lens status of participants who had undergone cataract surgery was recorded, and these participants were asked where they had received care.

Participants with obvious lens opacity and vision impairment or blindness with pinhole were asked the reasons for not having received cataract surgery.

All survey participants were invited to undergo a diabetes assessment, which involved asking whether they had previously been diagnosed with the disease and then to have a random blood glucose test done by finger prick. Those with known diabetes were also asked about when they were first diagnosed, and whether an eye examination had been conducted since being diagnosed.

All participants with known or suspected diabetes were invited to undergo a dilated retinal examination using direct and indirect ophthalmoscopy. The pupil of consenting participants was dilated with tropicamide 0.5% eye solution, and after 30 minutes the examination was conducted in a darkened room, checking for retinal haemorrhages, exudates, and evidence of previous laser treatment, with retinopathy graded using the Scottish DR Grading Scheme (see Table 1).

Participants identified as requiring further eye care were counselled and referred to appropriate services.

Local modifications to the RAAB form

The standard list of RAAB causes can be edited according to the survey setting. During the training program, it was noted that onchocerciasis was not present in Vanuatu. The survey teams decided to replace the condition 'onchocerciases' on the record survey with 'pterygium', as this is known to be prevalent in Vanuatu and not included in the standard list of causes of blindness and vision impairment in the RAAB survey form.

Data management and analysis

Data was recorded on android mobile tablets using the RAAB application. Data from the RAAB application were then transmitted via a secure encrypted connection to the RAAB data management software, located on a secure cloud-based server (Version 7, London School of Hygiene & Tropical Medicine, UK).

The data was assessed regularly with the RAAB software's in-built consistency check function. Any discrepancies identified were immediately flagged with the team leaders by the RAAB trainer for clarification and then rectified as appropriate.

Once data collection and cleaning were completed, the RAAB Trainer closed the survey, locking the dataset. The Principal Investigator and Vanuatu Ministry of Health downloaded automated reports and a copy of the data for local storage, while the raw dataset and reports were also securely backed up for safekeeping by the International Centre for Eye Healthat the London School of Hygiene and Tropical Medicine.

The Vanuatu Ministry of Health also gave permission for the main survey outputs [ii] , survey reports and anonymised survey data produced by the London School of Tropical Hygiene and Medicine to be shared on the RAAB repository.

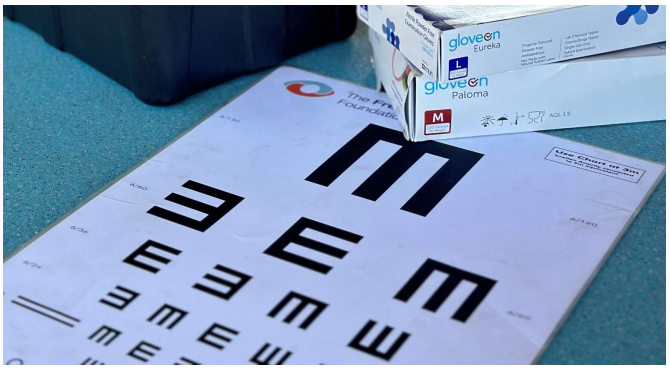
Ethical and other approvals obtained

Approval for the implementation of this research study was granted by the Vanuatu Ministry of Health Ethics and Research Committee. Consent was obtained from each regional and village administration prior to the survey. Informed consent was also sought from all eligible subjects eligible to participate at the time of data collection.

A participant information sheet and consent form were developed to explain the study's purpose, procedures, risks, benefits, confidentiality considerations, and the voluntary nature of participation in the survey. Provided in English, Bislama, or French, they were explained, read and given to participants, who then provided written consent if they chose to participate in the study.

Survey teams mitigated any stress caused by new diagnoses by providing adequate counselling on the spot and referring participants to health facilities to receive care as appropriate.

Completed consent forms were securely stored, and the participants' identifiable data that was initially entered in the RAAB mobile tablet used for data collection were deleted post-survey.



[ii] Prevalence of vision impairment and blindness, main causes of vision impairment and blindness, cataract surgical coverage, effective cataract surgical coverage, and effective refractive error coverage (total, male, female).

RESULTS

Response rate

The survey included 5,680 people aged 50 years and older, of whom 4,965 were examined. The coverage was 87.4%: 593 eligible individuals (10.4%) were absent, 36 (0.6%) refused to participate in the study, and 86 (1.5%) were unable to comply with the examination (Table 2).

Table 2. Eligible persons, coverage, absentees, and refusals

	Total eligible		Examined		Not available		Refused		Not capable	
	n	%	n	%	n	%	n	%	n	%
Total	5,680	100.0	4,965	87.4	593	10.4	36	0.6	86	1.5
Women	2,918	100.0	2,576	88.3	283	9.7	16	0.5	43	1.5
Men	2,762	100.0	2,389	86.5	310	11.2	20	0.7	43	1.6

Representativeness of study population

To check whether the study population is representative of the Vanuatu population aged 50 years and older, the age and sex composition of the sample was compared with that of broader population of Vanuatu (Table 3).

Ideally, the study population should have the same composition by age and by gender as the total population aged 50 years and older in the survey area. However, we found that men were under-represented in the 50 to 59 years age group, and that they were over-represented in the 70 to 79 years, and 80 years and older age groups. Women were slightly under-represented in the 50 to 59 years and 70-79 years age groups.

To account for these discrepancies, we have provided both crude (study population) and age- and sex-adjusted estimates where appropriate.

Table 3. Age and gender composition of country and sample population

	Women		Men		Total	
	Sample	National	Sample	National	Sample	National
	n (% total 50+)	n (% total 50+)	n (% total 50+)	n (% total 50+)	n (% total 50+)	n (% total 50+)
50-59 years	1,270 (49.3)	8,749 (48.0)	1,032 (43.2)	9,515 (47.2)	2,302 (46.4)	18,264 (47.6)
60-69 years	823 (31.9)	5,743 (31.5)	736 (30.8)	6,436 (31.9)	1,559 (31.4)	12,179 (31.7)
70-79 years	380 (14.8)	2,942 (16.1)	440 (18.4)	3,308 (16.4)	820 (16.5)	6,250 (16.3)
80+ years	103 (4.0)	801 (4.4)	181 (7.6)	898 (4.5)	284 (5.7)	1,699 (4.4)

Prevalence of blindness and vision impairment

Study population

The crude prevalence of blindness with available correction was 1.7% (95%CI: 1.3-2.1%). The crude prevalence of SVI, MVI, and EVI were 1.8% (95%CI 1.3%-2.3%), 10.4% (95%CI 9.2%-11.5%), and 8.0% (7.1%-8.9%), respectively. No statistically significant differences were observed between women and men in the prevalence of blindness and vision impairment (Table 4).

Table 4. Crude prevalence of blindness by impairment level and gender

Bilateral PVA	Women		Men		Total	
	n	% (95%CI)	n	% (95%CI)	n	% (95%CI)
Blindness (PVA <3/60)	41	1.6 (2.0-2.1)	44	1.8 (1.3-2.4)	85	1.7 (1.3-2.1)
SVI (PVA <6/60 – 3/60)	44	1.7 (1.1-2.3)	45	1.9 (1.3-2.5)	89	1.8 (1.3-2.3)
MVI (PVA <6/18 – 6/60)	261	10.1 (8.7-11.5)	254	10.6 (9.1-12.1)	515	10.4 (9.2-11.5)
EVI (PVA <6/12 – 6/18)	217	8.4 (7.3-9.6)	181	7.6 (6.4-8.8)	398	8.0 (7.1-8.9)

Age- and sex-adjusted

The age- and sex-adjusted prevalence of blindness with available correction (i.e. PVA) was 1.7% (95%CI 1.3%-2.0%). The age- and sex-adjusted prevalence of SVI, MVI, and EVI were 1.7% (95%CI 1.2%-2.2%), 10.0% (95%CI 8.8%-11.1%), and 7.7% (95%CI 6.9%-8.6%), respectively. No statistically significant differences were observed between women and men (Table 5).

Based on the observed prevalence, an estimated 8,089 people aged 50 years and older – 4,140 women and 3,949 men – have vision loss in Vanuatu. These numbers include 640 who are blind.

Table 5. Age- and sex- adjusted prevalence of blindness and extrapolated magnitude by impairment and gender

Bilateral PVA	Women		Men		Total	
	% (95%CI)	n	% (95%CI)	n	% (95%CI)	n
Blindness (PVA <3/60)	1.7 (1.1-2.2)	304	1.7 (1.1-2.2)	336	1.7 (1.3-2.0)	640
SVI (PVA <6/60 – 3/60)	1.8 (1.2-2.4)	324	1.6 (1.0-2.2)	326	1.7 (1.2-2.2)	650
MVI (PVA <6/18 – 6/60)	10.6 (9.2-12.0)	1,930	9.4 (7.9-10.9)	1,899	10.0 (8.8-11.1)	3,829
EVI (PVA <6/12 – 6/18)	8.7 (7.5-9.8)	1,582	6.9 (5.7-8.1)	1,388	7.7 (6.9-8.6)	2,970

Causes of blindness and vision impairment in the study population

Untreated cataract was the most common cause of blindness identified in the study population. This condition accounted for 82.4% of cases, with posterior segment disease only accounting for 4.7% as the second leading cause. Uncorrected refractive errors, cataract surgical complications, DR, and globe/central nervous system (CNS) abnormalities all accounting for 2.4% of blindness. Cataract was also the main cause of SVI (91.0%) and MVI (66.0%). Uncorrected refractive errors were the leading cause of EVI (76.9%) and caused 5.6% of SVI and 27.2% of MVI in the study population (Table 6).

The proportion of blindness due to glaucoma was 1.2%, or only one participant. However, it should be noted that with glaucoma the central vision remains unaffected until very late in the disease process. It was not possible to conduct reliable visual field analysis in this survey. The number of patients who have glaucoma and still have normal VA is likely to be higher.

Ninety-two percent of all blindness in the study population was avoidable. Specifically, 84.8% of blindness was treatable, 1.2% was preventable with primary health care (PHC) and/or primary eye care, and 6.0% was preventable through more advanced ophthalmic services. Posterior segment diseases accounted for 8.3% of all bilateral blindness.

The distribution of causes was similar between women and men.

Table 6. Main causes of blindness, SVI, MVI and EVI in the study population

	Blindness		SVI		MVI		EVI	
	n	%	n	%	n	%	n	%
By cause								
Cataract, untreated	70	82.4	81	91.0	340	66.0	83	20.9
Other posterior segment disease	4	4.7	1	1.1	4	0.8	2	0.5
Refractive error, uncorrected	2	2.4	5	5.6	140	27.2	306	76.9
Cataract surgical complications	2	2.4	0	0.0	7	1.4	2	0.5
All other globe/CNS abnormalities	2	2.4	0	0.0	5	1.0	0	0.0
DR	2	2.4	0	0.0	5	1.0	0	0.0
Glaucoma	1	1.2	0	0.0	0	0.0	0	0.0
Phthisis	1	1.2	0	0.0	0	0.0	0	0.0
Age-related macular degeneration	0	0.0	1	1.1	0	0.0	2	0.5
Trachomatous corneal opacity	0	0.0	0	0.0	1	0.2	0	0.0
Aphakia, uncorrected	0	0.0	0	0.0	0	0.0	0	0.0
Myopic degeneration	0	0.0	0	0.0	0	0.0	0	0.0
Pterygium	0	0.0	0	0.0	0	0.0	0	0.0
Other corneal opacity	0	0.0	0	0.0	0	0.0	0	0.0
By intervention category								
A. Treatable	72	84.8	86	96.6	480	93.2	389	97.8
B. Preventable (PHC/PEC services)	1	1.2	0	0.0	1	0.2	0	0.0
C. Preventable (Ophthalmic services)	5	6.0	0	0.0	12	2.4	3	0.8
D. Avoidable (A+B+C)	78	92.0	86	96.6	493	95.8	392	98.6
E. Posterior segment causes	7	8.3	2	2.2	9	1.8	5	1.3

PHC: Primary Health Care; PEC: Primary Eye Care

Cataract

Crude prevalence of cataract by pinhole visual acuity

The crude prevalence of blindness due to bilateral cataract among people aged 50 years and older was 0.6% (95%CI: 0.3%-0.8%); the crude prevalence of blindness due to unilateral cataract was 3.5% (95%CI 2.9%-4.2%) (Table 7).

The crude prevalence of SVI+ due to bilateral cataract was 1.2% (95%CI 0.9%-1.6%); the crude prevalence of SVI+ due to unilateral cataract was 4.4% (95%CI 3.7%-5.1%) (Table 7).

The crude prevalence of MVI+ due to bilateral cataract was 4.6% (95%CI 3.8%-5.4%); the crude prevalence of MVI+ due to unilateral cataract was 7.8% (95%CI 6.9%-8.8%) (Table 7).

The crude prevalence of EVI+ due to bilateral cataract was 9.6% (95%CI 8.4%-10.7%); the crude prevalence of EVI+ due to unilateral cataract was 9.8% (95%CI 8.9%-10.8%) (Table 7).

No significant differences in the crude prevalence of cataract at any surgical threshold were observed between women and men

Table 7. Crude prevalence of cataract at surgical thresholds <3/60, <6/60, <6/18 and <6/12

	Women		Men		Total	
	n	% (95%CI)	N	% (95%CI)	n	% (95%CI)
Blind (PinVA<3/60)						
Bilateral cataract	17	0.7 (0.3-1.0)	11	0.5 (0.2-0.8)	28	0.6 (0.3-0.8)
Unilateral cataract	76	3.0 (2.2-3.7)	100	4.2 (3.3-5.1)	176	3.5 (2.9-4.2)
SVI+ (PinVA <6/60)						
Bilateral cataract	33	1.3 (0.8-1.8)	28	1.2 (0.7-1.7)	61	1.2 (0.9-1.6)
Unilateral cataract	99	3.8 (3.1-4.6)	118	4.9 (4.0-5.9)	217	4.4 (3.7-5.1)
MVI+ (PinVA <6/18)						
Bilateral cataract	115	4.5 (3.4-5.5)	112	4.7 (3.7-5.7)	227	4.6 (3.8-5.4)
Unilateral cataract	186	7.2 (6.1-8.4)	203	8.5 (7.2-9.8)	389	7.8 (6.9-8.8)
EVI+ (PinVA <6/12)						
Bilateral cataract	250	9.7 (8.2-11.2)	225	9.4 (8.0-10.9)	475	9.6 (8.4-10.7)
Unilateral cataract	219	8.5 (7.3-9.7)	270	11.3 (10.0-12.6)	489	9.8 (8.9-10.8)

Age- and sex-adjusted prevalence of cataract by pinhole visual acuity

The age- and sex-adjusted prevalence of blindness due to bilateral cataract among people aged 50 years and older was 0.5% (95%CI: 0.3%-0.8%); the age- and sex-adjusted prevalence of blindness due to unilateral cataract was 3.5% (95%CI 2.8%-4.1%) (Table 8).

The age- and sex-adjusted prevalence of SVI+ due to bilateral cataract was 1.2% (95%CI 0.8%-1.5%); prevalence of SVI+ due to unilateral cataract was 4.2% (95%CI 3.5%-4.9%) (Table 8).

The age- and sex- adjusted prevalence of MVI+ due to bilateral cataract was 4.3% (95%CI 3.5%-5.1%); the prevalence of MVI+ due to unilateral cataract was 7.7% (95%CI 6.7%-8.6%) (Table 8).

The age- and sex-adjusted prevalence of EVI+ due to bilateral cataract was 9.1% (95%CI 7.9%-10.3%); the prevalence of EVI+ due to unilateral cataract was 9.6% (95%CI 8.7%-10.6%) (Table 8).

It was estimated that the number of people who have bilateral blindness and have a bilateral vision of <3/60 and <6/18 in Vanuatu is 200 and 1,650, respectively. The number of people who are blind in one eye or have a vision of <3/60 and <6/18 in one eye from cataract is 1,329 and 2,945, respectively. (Table 7)

No significant differences in the age- and sex-adjusted prevalence of cataract at any surgical threshold were observed between women and men.

Table 8. Age- and sex-adjusted results for cataract and PinVA <3/60, <6/60 and <6/18 among people aged 50 years and older in Vanuatu

	Women		Men		Total	
	n	% (95%CI)	n	% (95%CI)	n	% (95%CI)
Blind (PinVA <3/60)						
Bilateral cataract	129	0.7 (0.3-1.1)	111	0.6 (0.2-0.9)	200	0.5 (0.3-0.8)
Unilateral cataract	562	3.1 (2.4-3.8)	767	3.8 (2.9-4.7)	1,329	3.5 (2.8-4.1)
SVI+ (PinVA <6/60)						
Bilateral cataract	250	1.4 (0.9-1.9)	251	1.2 (0.7-1.8)	445	1.2 (0.8-1.5)
Unilateral cataract	730	4.0 (3.2-4.8)	897	4.5 (3.5-5.4)	1,627	4.2 (3.5-4.9)
MVI+ (PinVA <6/18)						
Bilateral cataract	858	4.7 (3.7-5.7)	916	4.5 (3.5-5.6)	1,650	4.3 (3.5-5.1)
Unilateral cataract	1,370	7.5 (6.4-8.7)	1,575	7.8 (6.6-9.1)	2,945	7.7 (6.7-8.6)
EVI+ (PinVA <6/12)						
Bilateral cataract	1,864	10.2 (8.7-11.7)	1,812	9.0 (7.5-10.4)	3,495	9.1 (7.9-10.3)
Unilateral cataract	1,601	8.8 (7.6-9.9)	2,096	10.4 (9.1-11.7)	3,697	9.6 (8.7-10.6)

Cataract surgical coverage and effective cataract surgical coverage

In this study 318 eyes had cataract surgery; 314 (98.7%) eyes had an intraocular lens (IOL) implanted and only one eye did not have an IOL.

Most patients were operated upon in government hospitals (96.2%), with only eight (2.5%) receiving surgery in charitable hospitals, one (0.3%) receiving surgery in a private hospital, and three (0.9%) receiving surgery in an eye camp. The visual outcome appeared to be best in the government hospitals, however number of surgeries outside of this setting are too low to draw any conclusions.

The CSC in persons indicates which proportion of people with cataract and a predefined VA have been operated on for cataract (Table 9). This indicator measures the coverage of cataract surgical services. At 79.2%, the age- and sex-adjusted CSC among people who are blind (PVA <3/60) was just below the target of at least 80% recommended by the International Agency for the Prevention of Blindness (IAPB).[16] This suggests that for every four persons operated on, there is one person who is blind from cataract. The CSC in men (82.8%) appears to be somewhat higher to that in women (75.0%); however, this difference was not significant in the survey population.

The age- and sex-adjusted CSC among people with a VA of <6/60, <6/18, and <6/12 was 65.6%, 38.9%, and 26.5%, respectively. This suggests that fewer people who have cataract receive surgery if they are not blind (Table 9).

The eCSC combines coverage and outcome of cataract surgery and indicates what proportion of the people with bilateral operable cataract have been operated upon in one or both eyes and can see 6/18 or better after surgery.[17] The eCSC among people who are blind was 54.6%. The eCSC among people with a VA of <6/60, <6/18, and <6/12 was 44.3%, 25.3%, and 16.3%, respectively (Table 9). The quality gap between CSC and eCSC was found to be 31.1%. 32.4%. 34.9%, and 38.4%, respectively.

Although these differences are not statistically significant, at the <3/60 threshold, CSC appeared to be higher among men (82.8%; 95%CI 74.2%-91.4%) than women (75.0%; 95%CI 63.7%-86.4%), whilst eCSC appeared to be higher among women (58.2%; 95%CI 45.7%-70.7%) than men (51.6%; 95% CI 41.2%-61.9%).

Table 9. Age- and sex-adjusted CSC and eCSC at the person level

	Women % (95%CI)	Men % (95%CI)	Total % (95%CI)	Relative Quality Gap %
Cataract surgical threshold <6/12				
CSC	22.6 (18.2-27.1)	30.4 (24.9-35.8)	26.5 (22.5-30.5)	38.4
eCSC	15.0 (11.2-18.7)	17.7 (13.2-22.2)	16.3 (13.0-19.7)	
Cataract surgical threshold <6/18				
CSC	35.3 (28.1-42.6)	42.1 (34.5-49.7)	38.9 (33.2-44.7)	34.9
eCSC	25.5 (19.0-31.9)	25.2 (19.0-31.5)	25.3 (20.4-30.3)	
Cataract surgical threshold <6/60				
CSC	61.5 (50.8-72.1)	69.1 (59.0-79.1)	65.6 (58.0-73.2)	32.4
eCSC	47.1 (36.4-57.8)	42.0 (32.2-51.9)	44.3 (36.7-52.0)	
Cataract surgical threshold <3/60				
CSC	75.0 (63.7-86.4)	82.8 (74.2-91.4)	79.2 (72.1-86.3)	31.1
eCSC	58.2 (45.7-70.7)	51.6 (41.2-61.9)	54.6 (46.3-62.9)	

If the indication for cataract surgery was PinVA <3/60 then 247 people aged 50 years and older would require surgery in at least one eye. If the indication for surgery was PinVA <6/60 then 515 people would require surgery in at least one eye. If the indication for surgery was PinVA <6/18 then 1,812 people would require surgery in at least one eye. Finally, if the indication for surgery was PinVA <6/12 then 3,787 people would require surgery in at least one eye.

Table 10. Extrapolated magnitude of unmet need for cataract surgery at pinhole VA thresholds <3/60, <6/60, <6/18, and <6/12

Unmet Need Threshold	Women		Men		Total	
	% (95%CI)	n	% (95%CI)	n	% (95%CI)	n
PinVA <3/60	0.7% (0.4 - 1.1)	136	0.6% (0.2 - 0.9)	111	0.6% (0.4 - 0.9)	247
PinVA <6/60	1.4% (0.9 - 2.0)	264	1.2% (0.7 - 1.8)	251	1.3% (1.0 - 1.7)	515
PinVA <6/18	4.9% (3.8 - 6.0)	895	4.5% (3.5 - 5.6)	916	4.7% (3.9 - 5.6)	1,812
PinVA <6/12	10.8% (9.3 - 12.4)	1,975	9.0% (7.4 - 10.5)	1,812	9.9% (8.6 - 11.1)	3,787

Visual outcome after cataract surgery

Overall good visual outcome was seen in 58.2% (PVA ≥6/18) and 75.8% (PinVA ≥6/18) of eyes with and without pinhole correction, respectively. Overall, a poor outcome by WHO definition [18] was seen in 10.4% (PVA <6/60) and 7.2% (PinVA <6/60) of eyes (Table 11).

The proportion of eyes with a poor outcome appeared to be somewhat lower in men (9.1% and 12.8% with and without pinole, respectively) compared to women (4.6% and 6.9% with and without pinhole, respectively); however, it is not possible to say so conclusively.

Table 11. Post-operative visual outcome (PinVA), count by eyes

Outcome	Women		Men		Total	
	n	%	n	%	n	%
PVA						
Good: 6/12	82	62.6	103	55.1	185	58.2
Borderline: 6/12 to 6/60	42	30.5	60	32.1	100	31.4
Poor: <6/60	9	6.9	24	12.8	33	10.4
PinVA						
Good: 6/12	103	78.6	138	73.8	241	75.8
Borderline: 6/12 to 6/60	22	16.8	32	17.1	54	17.0
Poor: <6/60	6	4.6	17	9.1	23	7.2
Total	131	100.0	187	100.0	318	100.0

Barriers to cataract surgery

The main barriers to cataract surgery were 'Need not felt' (53.8%), 'Cannot access treatment' (15.4%), 'Cost' (9.0%), and 'Unaware that treatment is possible (6.4%), followed by 'Surgery denied by provider' (1.3) and 'Fear' (1.3%) (Table 12).

Table 12. Barriers to cataract surgery in study population (bilateral PinVa <6/60 due to cataract)

Barrier	Women		Men		Total	
	n	%	n	%	n	%
Need not felt	25	61	17	45.9	42	53.8
Cannot access surgery	5	12.2	7	18.9	12	15.4
Cost	2	4.9	5	13.5	7	9.0
Unaware treatment possible	2	4.9	3	8.1	5	6.4
Surgery denied by provider *	0	0.0	1	2.7	1	1.3
Fear	1	2.4	0	0.0	1	1.3
Other	6	14.6	4	10.8	10	12.8
Total	41	100.0	37	100.0	78	100.0

*Participants can report one or two barriers each; * Surgery denied by the provider" means that a healthcare provider or facility refused to perform cataract surgery for a patient, even though the patient sought treatment. This could happen due to various reasons, such as the patient being deemed unsuitable for surgery (e.g., due to other health conditions).*

Refractive error

Crude prevalence of distance refractive error

In population-based surveys, refractive error is often defined by an improvement in visual acuity with correction to a specific VA threshold (rather than e.g., in dioptres of myopia). The definition of refractive error used in RAAB7 is UCVA worse than 6/12 improving to 6/12 with spectacle correction or pinhole.

The crude prevalence of distance refractive errors was 10.9% (Table 13); this increased with age and was highest among those aged 70 years and older. Uncorrected refractive error was the leading cause of EVI (76.9%) and the second leading cause of MVI (27.2%).

Table 13. Crude prevalence of distance refractive error by age group and gender

	Women		Men		Total	
	n	% (95% CI)	n	% (95% CI)	n	% (95% CI)
50-59 years	52	4.1% (2.9 - 5.3)	47	4.6% (3.3 - 5.8)	99	4.3% (3.4 - 5.2)
60-69 years	118	14.3% (11.8 - 16.9)	76	10.3% (8.1 - 12.6)	194	12.4% (10.7 - 14.2)
70-79 years	86	22.6% (18.6 - 26.6)	104	23.6% (19.5 - 27.8)	190	23.2% (20.3 - 26.0)
80+ years	17	16.5% (9.3 - 23.7)	43	23.8% (17.8 - 29.7)	60	21.1% (16.5 - 25.7)
Total	273	10.6% (9.3 - 11.9)	270	11.3% (9.8 - 12.8)	543	10.9% (9.9 - 11.9)

Refractive error coverage and effective refractive error coverage

Age- and sex-adjusted REC and eREC were 12.6% (95%CI 9.8%-15.3%) and 10.3% (95%CI 7.7%-12.9%), respectively. Both REC and eREC appeared to be higher among men (15.0% and 13.0%), compared with women (7.5% and 10.0%) (Table 14). However, this difference was not statistically significant, as indicated by the overlapping 95% confidence intervals.

Table 14. Age- and sex-adjusted distance eREC and REC

	Women	Men	Total
	% (95%CI)	% (95%CI)	% (95%CI)
eREC	7.5 (4.2 - 10.7)	13.0 (9.2 - 16.8)	10.3 (7.7 - 12.9)
REC	10.0 (6.4 - 13.7)	15.0 (10.7 - 19.2)	12.6 (9.8 - 15.3)

Need for distance refractive error correction

An estimated 4,073 people aged 50 years and older in Vanuatu need distance refractive error correction. Of these, only 420 (10.3%) have this need met. Almost nine in 10 (87.4%) older adults with distance refractive error correction did not have glasses, and a further 2.3% had correction that was inadequate (Table 15).

Table 15. Age- and sex-adjusted prevalence of met need, undermet need, unmet need and no need for distance refractive error correction by gender

Error Correction	Women		Men		Total	
	% (95%CI)	n	% (95%CI)	n	% (95%CI)	n
Met need	0.8% (0.4 - 1.2)	148	1.3% (0.9 - 1.8)	272	1.1% (0.8 - 1.4)	420
Undermet need	0.3% (0.0 - 0.7)	50	0.2% (0.0 - 0.7)	41	0.2% (0.0 - 0.6)	92
Unmet need	9.8% (8.2 - 11.3)	1,781	8.8% (7.5 - 10.2)	1,780	9.3% (7.9 - 10.7)	3,561
No need	89.1% (74.1 - 100.0)	16,255	89.6% (74.6 - 100.0)	18,064	89.4% (74.6 - 100.0)	34,319

Diabetic Retinopathy

The study assessed the prevalence of diabetes among participants. Almost all participants (99.4%) who had their eyes examined agreed to have their diabetes status assessed. Of these, 13.3% were identified as having known or suspected diabetes (Table **16**). It should be noted that the use of random blood glucose (RBG) testing without fasting may result in over-estimates of suspected diabetes in RAAB surveys.

Among those identified as having high RBG readings , almost two thirds (63.4%) were known diabetics (65.1% of women and 61.4% of men), while 36.6% were suspected diabetics (34.9% of women and 38.6% of men) (Table **16**). The majority of these individuals (88.9%) consented to a dilated fundus examination (Table **16**).

Table 16. Known or suspected diabetes among participants assessed fordiabetes status

Exam status	Women		Men		Total	
	n	%	n	%	n	%
Known or suspected diabetes	350	13.7	308	13	658	13.3
Known	228	65.1	189	61.4	417	63.4
Suspected*	122	34.9	119	38.6	241	36.6
Consented dilated examination	307	87.7	278	90.3	585	88.9

** No known history of diabetes but random blood glucose 200mg/dl or higher*

Self-reported time since last eye examination for DR among known diabetics can be considered as a proxy for the coverage of DR (screening) services. The majority of participants with known or suspected diabetes had never undergone an eye examination for DR, with 85.9% reporting no previous examination (84.2% of women and 87.8% of men) (Table 17). Only 8.6% had been examined within the past year (10.1% of women and 6.9% of men), while smaller percentages had been examined within 1-2 years (2.4%) or more than two years ago (3.1%) (Table 17). These findings indicate a substantial gap in the coverage of DR screening services among known diabetics. Recall bias may affect the reliability of the findings and results should be reviewed alongside facility-based DR screening records where available.

Table 17. Self-reported time since last eye examination for DR among known diabetics

Last exam	Women		Men		Total	
	n	%	n	%	n	%
Never	192	84.2	166	87.8	358	85.9
Within 1 year	23	10.1	13	6.9	36	8.6
1-2 years	6	2.6	4	2.1	10	2.4
More than 2 years	7	3.1	6	3.2	13	3.1
Total	228	100	189	100	417	100

The crude prevalence of retinopathy and maculopathy was evaluated among those who consented to the dilated fundus examination, with the grades determined as the higher of the grades in the two eyes. Table 18 provides detailed data on the grades of retinopathy and maculopathy among known and suspected diabetics. Among these individuals, three quarters (74.5%) had no retinopathy (R0), with more men (78.3%) compared to women (71.0%) presenting with no retinopathy. Mild retinopathy (R1) was present in 14.6% of participants, with a higher incidence in women (16.3%) than in men (12.6%). Observable retinopathy (R2) was found in 2.9% of the participants (3.6% of women and 2.2% of men). Referable retinopathy (R3) was noted in 1.7% of the participants, with a higher prevalence in women (2.6%) compared to men (0.7%). Proliferative retinopathy (R4) was identified in 2.1% of participants (2.3% of women and 1.8% of men). The retinopathy grade could not be visualized (R6) in 4.3% of participants, with similar rates in women (4.2%) and men (4.3%).

For maculopathy, 81.8% of participants had no signs of maculopathy (M0), with more men (85.9%) compared to women (78.2%) presenting with no maculopathy. Observable maculopathy (M1) was found in 6.3% of participants (7.8% of women and 4.7% of men). Referable maculopathy (M2) was present in 7.5% of participants, with a higher incidence in women (9.8%) than in men (5.1%). The maculopathy grade could not be visualized (M6) in 4.3% of participants, with similar rates in women (4.2%) and men (4.3%).

Table 18. Grade of retinopathy and maculopathy among (known and suspect) diabetics

	Women		Men		Total	
	n	%	n	%	n	%
Retinopathy						
None (R0)	218	71	217	78.3	435	74.5
Mild (R1)	50	16.3	35	12.6	85	14.6
Observable (R2)	11	3.6	6	2.2	17	2.9
Referable (R3)	8	2.6	2	0.7	10	1.7
Proliferative (R4)	7	2.3	5	1.8	12	2.1
Not visualised (R6)	13	4.2	12	4.3	25	4.3
Maculopathy						
None (M0)	240	78.2	238	85.9	478	81.8
Observable (M1)	24	7.8	13	4.7	37	6.3
Referable (M2)	30	9.8	14	5.1	44	7.5
Not visualised (M6)	13	4.2	12	4.3	25	4.3

Graded using the Scottish DR Grading Scheme

Although it is not possible to comment on the statistical significance of differences between women and men when it comes to diabetes and DR, these findings suggest that although men have a somewhat higher prevalence of diabetes, the prevalence of any retinopathy, referrable retinopathy, and maculopathy is higher among women compared with men.

DISCUSSION

The 2023 Vanuatu RAAB survey provides a comprehensive analysis of the current state of eye health in the country, revealing important insights into both significant achievements and opportunities for work going forward.

The age- and sex-adjusted prevalence of blindness among adults aged 50 years and older in Vanuatu was found to be 1.7%, which, while still a concern, is lower than in some neighbouring Pacific Island Countries for which comparable data is available. For example, the prevalence of blindness was found to be 5.6% in the same age cohort in Papua New Guinea in 2018 [19] and 2.6% among adults aged 40 years and older in Fiji in 2014. [20] The 1992 national survey of eye health reported a prevalence of blindness among Ni-Vanuatu of 1.3% (95%CI 0.2%-3.7%) for 50- to 59-year-olds, of 1.4% (95%CI 0.01%-4.5%) for 60- to 69-year-olds, and of 0.7% (95%CI 0.01%-2.7%) for people aged 70 years and older. [11] Although estimated prevalence from 1992 appears similar or lower to the prevalence in this study, it is important to note that the 1992 estimates have wide 95% confidence intervals. The confidence interval for blindness in this study is relatively narrow (1.3%-2.1%) and the upper value is lower than the upper values for the three age groups in the 1992 survey. The prevalence of blindness identified in this survey is also broadly consistent with the prevalence of Ni-Vanuatu (1.5%) reporting that they had a severe or total visual disability in the 2020 national census. [9] The Vision Atlas of the IAPB estimates that the age- and sex-adjusted prevalence of blindness among adults aged 50 years and older in Oceania is 1.98%; [21] it should be noted, however, that because of the lack of national, population-based surveys in the region, the data provided in the Vision Atlas is from the model developed by the Vision Loss Expert Group, which in turn is affiliated with the Global Burden of Disease Study. Indeed, projections from the Vision Loss Expert Group for the region are made with very few reports from Pacific Island Countries, which understandably creates uncertainty in the estimates generated. [6] For example, the Vision Atlas had estimated that in 2020 the prevalence of blindness among people aged 50 years and older in Vanuatu and Fiji was 1.07 [22] and 2.20%, [23] respectively; it is therefore possible that the overall prevalence projections for the region are in fact underestimates.

The survey identified cataract as the leading cause of blindness, SVI, and MVI in Vanuatu, responsible for 82.4%, 91.0% and 66.0% of cases, respectively. Uncorrected refractive errors were the leading cause of EVI and the second-leading cause of MVI. This pattern is consistent with other Pacific Island Countries, where cataract and uncorrected refractive errors are also the leading causes of vision impairment. [24] The high prevalence of untreated cataract underscores the need for increased surgical capacity and outreach programs to address this preventable cause of blindness.

The CSC considering a VA threshold for surgery of <3/60 was found to be 79.2%. Though there is no internationally accepted target as to what constitutes an adequate CSC, the 80% threshold has been used in discussions around the Universal Health Coverage target to be included within the Sustainable Development Goals. [16] The CSC among people who are blind from cataract in Vanuatu sits just below this threshold. The only other country in the Western Pacific Region for which there is comparable data, and which has achieved CSC that is at or higher than the 80% threshold is Malaysia. [25]

When considering a VA threshold for surgery of <6/18 (*cf.* <3/60) the CSC for people in Vanuatu was found to be 38.9%; this is consistent with available data from other countries in the Western Pacific Region, which have a CSC ranging from approximately 20% to 60% and a median of around 40%. [26] The global median for CSC using a VA threshold for surgery of <6/18 is also 40%. In practice, this results in an estimated backlog of 3,695 individuals with bilateral blindness or bilateral VA of <6/18 from cataract, and a backlog of 5,026 people who have unilateral blindness or unilateral VA of <6/18 from cataract.

The main barriers to accessing cataract surgery were ‘Need not felt’ (53.8%), ‘Cannot access treatment’ (15.4%), ‘Cost’ (9.0%). The high proportion of those citing ‘Need not felt,’ ‘Unaware that treatment is possible,’ and ‘Fear’ suggests a significant gap in awareness and knowledge about the benefits of cataract surgery and may also point to the fact that many older people accept gradual vision loss as inevitable and adapt to declining vision over time; This indicates a need for targeted health education. Additionally, barriers related to ‘Cost’ and ‘Cannot access treatment’ highlight ongoing issues with

affordability and accessibility of services, which need to be addressed to improve surgical uptake.

The eCSC among people who are blind in Vanuatu was 54.6%. This indicates that while cataract surgery outputs (i.e., the number of surgeries) are relatively high, the quality and outcomes of these surgeries are not optimal. When considering a threshold for surgery of <6/18, the eCSC was found to be 25.3%. The interquartile ranges for eCSC at this threshold in the Western Pacific Region are approximately 10% to 50% and, at approximately 30%, the regional median is somewhat higher than that of Vanuatu. [26]

The gap between CSC and eCSC values can be considered a quality gap, with lower values reflecting better quality of cataract surgery. The quality gap in Vanuatu was found to be 31.1% and 34.9% for surgical VA thresholds of <3/60 and <6/18, respectively. This highlights the need for enhanced surgical training, better postoperative care, and follow-up services to ensure that patients achieve the best possible visual outcomes. Indeed, it has been recommended that countries with a quality gap of 25% or higher should choose to particularly invest in quality improvement initiatives before focusing on actions to increase access or outputs. [26]

Further, good visual outcome was seen in 58.2% (PVA ≥6/18) and 75.8% (PinVA ≥6/18) of eyes with and without pinhole correction, respectively. The difference between PVA and PinVA can be minimised by adequate biometry, good surgical technique, individually adjusted IOLs, and optical correction after cataract surgery.

One in ten surgeries (10.4%) resulted in a poor outcome (PVA <6/60). This highlights the need for enhanced surgical techniques and postoperative care to improve visual outcomes. WHO recommends that after surgery no more than 5% of the operated eyes should have a PVA of <6/60, which is referred to as poor visual outcome. [27]

In this context, however, it is important to note that the questionnaire and data collection process did not account for comorbidities and underlying health conditions at the time of surgery, which can also significantly influence surgical outcomes beyond the quality of surgery itself and postoperative care.

The eREC in Vanuatu was found to be 10.3%, with findings suggesting a higher prevalence in men (13.0%) compared to women (7.5%). This low coverage indicates that a large proportion of individuals with refractive errors are not receiving the necessary corrective services. There is limited data available on eREC in the Western Pacific Region; however, global estimates suggest that the eREC among women and men aged 50 years and older in lower-middle income countries is 13.6%, which slightly higher than that observed in Vanuatu. [28]

eCSC and eREC are WHO indicators that measure not only the availability of cataract surgeries and corrective services for refractive errors but also the quality of these services, by assessing how many people achieve good vision outcomes after receiving them. These indicators are crucial because they ensure that vision improvement efforts are not only widespread but also effective, helping to reduce avoidable blindness and vision impairment, especially in underserved populations. WHO endorsed global targets for eCSC and eREC to be achieved by 2030. [29, 30] These targets aim for a 30% increase in eCSC and a 40% increase in eREC from baseline levels. Achieving these targets will help reduce avoidable blindness and vision impairment, contributing to necessary progress towards the Sustainable Development Goals. [31]

The prevalence of known or suspected diabetes in Vanuatu was found to be 13.3% among those aged 50 years and older. NCDs. including cardiovascular diseases, diabetes, cancer, and chronic respiratory diseases, represent the single largest cause of premature mortality in the Pacific Islands. [32] Nonetheless, the prevalence of diabetes and suspected diabetes in this study was lower than that found in the national WHO STEPS Survey that was conducted in 2011. The STEPS survey reported an overall prevalence of diabetes of 21.2% among 25- to 64-year-olds, and a prevalence of 26.2% and 31.5% among 45- to 54-year-olds and 55- to 64-year-olds, respectively. [13] It should be noted, however that the prevalence of diabetes in the STEPS survey was based on raised fasting glucose levels of 110 mg/dL, whereas WHO now defines a diagnosis of diabetes as fasting glucose levels of 126 mg/dL or greater. [33] Indeed, a 2021 study published in the Lancet estimated the overall prevalence of diabetes for all ages in Vanuatu to be 11.9% (i.e. prevalence rate of 11,093.3 per 100,000 population), [34] and the WHO reports that one in 11 in Vanuatu (or approximately 9.0%) live with diabetes. [35] Plans for another STEPS survey are included in the Vanuatu Non-Communicable Disease Policy & Strategic Plan 2021-2030. [36] Data from the nest

STEPS survey should be compared with data from this RAAB.

Of the study participants with known or suspected diabetes, 21.2% had some form of retinopathy and 8.0% presented with sight-threatening DR. This is consistent with estimated prevalence at the global level, with a 2021 systematic review and meta-analysis reporting that 22.27% of people with diabetes have some form of retinopathy and 6.17% have sight-threatening DR. [37] Previous studies from Vanuatu have largely found a higher prevalence of DR and sight-threatening DR. For example, Win Tin *et al*. [7] reported that 42% of people with diabetes in Vanuatu had any retinopathy. Similarly, Smith *et al*. [38] found that 52.9% of people with diabetes had any retinopathy and 22.1% had sight-threatening DR. The higher prevalence found in previous studies is likely accounted for by the fact that the study populations recruited registered patients who were likely to have had a longer duration of diabetes compared to those found through the RAAB's population-based approach and that the sample sizes of the previous studies were relatively small. Additionally, it is possible that the difference in DR prevalence observed between this RAAB and previous study is also partly due to different grading systems having been used. Whilst the Scottish DR Grading System was used in this RAAB, Win Tin *et al*. [7] do not detail the grading approach used in their study and Smith *et al*. [38] reported using the UK National Screening Committee Recommendations.

Nonetheless, this highlights a critical public health issue, as diabetes management and regular screening for DR are essential to prevent vision loss.

The survey also revealed that 85.9% of known diabetics in Vanuatu had never undergone an eye examination for DR. There is limited prior evidence relating to this from Vanuatu. Caceres *et al.* [39] found that only about half (55%) of people with diabetes reported a prior dilated retinal exam. It should be noted that participants in Caceres *et al*. were patients with diabetes with appointments at the three principal hospitals in Vanuatu. This lack of regular screening and subsequent treatment exacerbates the risk of vision loss among individuals with diabetes; understanding the underlying reasons for this low screening rate is therefore essential for addressing the issue effectively. Potential factors could include a lack of awareness among healthcare providers regarding the importance of DR screening, insufficient communication to patients about the need for such exams, or a shortage of the necessary diagnostic equipment for screening. Additionally, it is possible that patients are aware of the need for screening but fail to follow up. Identifying whether the root cause is related to provider knowledge, technical limitations, or patient compliance could inform the strategic allocation of resources to improve DR screening rates. Nonetheless, addressing this gap will require strengthening the integration of diabetes care with eye health services, to ensure that individuals receive comprehensive care that includes regular eye examinations and timely treatment for DR.

The study highlighted both similarities and differences between women and regarding eye health and access to treatment in Vanuatu. The prevalence of blindness and vision impairment does not show significant gender differences. For instance, at 1.7% the age- and sex-adjusted prevalence of blindness with available correction is the same between women and men. Moreover, the distribution of the main causes of blindness, such as untreated cataract, uncorrected refractive errors, and DR, is also comparable between genders.

However, there are notable differences in access to and outcomes of cataract surgery. Although this difference is not significant, the CSC tends to be higher for men than women across various visual acuity thresholds. For example, CSC (PVA <3/60) for men is 82.8% compared with 75.0% for women. eCSC (PVA <3/60) also shows a gender disparity, although in this instance eCSC was lower among men (51.6%) compared with women (58.2%). This is reflected in visual outcomes after cataract surgery, with surgery in men resulting in poor PVA (<6/60) and PinVA (<6/60) in 12.8% and 9.1% of cases, respectively. This is compared with surgery in women resulting in poor PVA (<6/60) and PinVA (<6/60) in 6.9% and 4.6% of cases, respectively. Finally, although prevalence of diabetes is similar among women and men, women appear to have higher prevalence of any retinopathy (24.8%) and sight-threatening DR (10.4%) than men (17.3% and 5.4%, respectively).

These findings suggest that while the overall prevalence of eye conditions may be similar, disparities exist in access to treatment and surgical outcomes, indicating the need for targeted interventions to ensure equitable eye health services for both genders.

Finally, it is worth noting that conducting the RAAB survey in Vanuatu has significantly contributed to building research capacity in the region. Through active

involvement in the survey, local health workers and researchers gained hands-on experience in conducting population-based studies, which strengthened their ability to interpret complex data and understand trends in vision impairment and blindness. This process has equipped them with the skills needed to make evidence-informed decisions, enabling better planning and implementation of eye health programs tailored to the specific needs of their communities. Moreover, the experience has fostered a sense of ownership and empowerment among local stakeholders, enhancing their ability to contribute to ongoing health initiatives and future research projects.

CONCLUSIONS

The RAAB survey highlighted both successes and challenges in the eye health sector in Vanuatu. The findings show relatively low prevalence of blindness, however significant gaps in CSC outcomes and coverage, as well as low REC and eREC remain. These gaps indicate a need for enhanced strategies to improve access to and quality of eye care services. The high prevalence of diabetes and the low screening rates for DR underscore the urgent need for integrated diabetes and eye care services. By implementing the recommendations outlined, Vanuatu can significantly improve its eye health outcomes and contribute to the regional goal of eliminating avoidable blindness and vision impairment.

RECOMMENDATIONS

1. Improve Cataract Surgery Outcomes and Increase Cataract Surgical Coverage

Enhancing surgical techniques and postoperative care to improve the effective cataract surgical coverage should be a priority. Efforts should also be made to increase the number of cataract surgeries performed, particularly targeting underserved populations. Outreach programs and mobile surgical units could help reach remote areas. To achieve this, the eye health sector in Vanuatu should work with all relevant stakeholders to:

1.1 Conduct an In-Country Workshops and Assessments:

- Host a workshop: Focus on understanding causes of poor outcomes and identify strategies for improvement. Engage local key stakeholders for sustainable progress.
- Map resources: Identify available equipment, facilities, and trained staff to expand services.

1.2 Invest in Training and Capacity Building:

- Upskill surgeons: Provide regular training in advanced techniques to boost surgery quality.
- Train support staff: Prepare nurses and technicians for comprehensive patient care.
- Standardize procedures: Develop standard operating procedures for consistent, high-quality care.

1.3 Expand Access through Mobile Clinics and Community Health Workers:

- Deploy mobile clinics: Reach remote areas and reduce patient travel costs.
- Engage community Health Workers: Use them for screenings and follow-ups to increase reach.
- Equip regional hospitals: Offer surgeries with visiting specialists to reduce waiting times.

1.4 Enhance Community Awareness and Health Education:

- Run awareness campaigns: Highlight benefits of cataract surgery and dispel misconceptions.

1.5 Implement Quality Assurance and Monitoring Systems:

- Track outcomes: Use centralized systems for monitoring results and improvements.
- Regular audits: Ensure adherence to SOPs and identify training needs.
- Patient feedback: Use feedback to refine care quality.

1.6 Strengthen Post-Operative Care and Follow-Up:

- Structure follow-ups: Monitor recovery and manage complications.
- Ensure medication access: Provide eye drops and corrective lenses as needed.
- Utilize community health workers: Support recovery in remote areas.

1.7 Improve Financial Accessibility to Cataract Surgery:

- Subsidize surgery: Partner with NGOs to make procedures affordable.
- Promote insurance Coverage: Advocate for cataract surgery inclusion in health insurance.
- Secure sustainable Funding: Collaborate with donors for long-term support.

1.8 Focus on Continuous Evaluation and Adaptation:

- Evaluate impact: track CSC and eCSC rates and adapt strategies accordingly.
- Scale successful models: Expand effective programs to other regions.
- Adjust based on feedback: Stay responsive to evolving community needs.

The first step is a thorough assessment of the current situation. This RAAB survey was a crucial first step in understanding the current cataract situation in Vanuatu. A workshop focussed on cataract could be held in country to further explore some of the potential causes of poor cataract surgery outcomes, discuss strategies to continue to improve coverage, and identify necessary and available resources such as equipment, surgical facilities, and trained personnel. Engaging key stakeholders, such as local health authorities, community leaders NGOs, WHO, and the IAPB is crucial to align goals and secure commitment for the initiativee.

With a clear understanding of the landscape, the focus then shifts to training and capacity building. Improving the skills of ophthalmologists through regular workshops on advanced surgical techniques and postoperative care is essential for enhancing surgical quality. At the same time, nurses and technicians should receive training in pre-operative assessments, intra-operative support, and post-operative care to ensure a comprehensive approach to patient management. Establishing standard operating procedures for cataract care ensures consistency and helps maintain high standards throughout the patient journey.

Expanding service delivery is key to reaching underserved populations, particularly those in remote areas. Outreach eye care services have been shown to be effective in increasing service coverage in hard-to-reach communities. [1, 40, 41] Mobile eye clinics can be deployed to provide cataract surgeries directly to these communities, reducing the need for travel and associated costs. Partnering with community health workers is an effective way to identify potential patients, conduct initial screenings, and provide follow-up support. Additionally, equipping regional hospitals to offer cataract surgery services can decentralize care and reduce waiting times, making surgery more accessible to those in need.

Community engagement plays a critical role in the success of this program. Awareness campaigns should be launched to educate the public about the benefits of cataract surgery, emphasizing that vision can be restored through simple procedures. Awareness and health promotion is covered in more detail in Recommendation 5.

To ensure the program's long-term success, quality assurance and monitoring are essential. A centralized system for tracking surgical outcomes, such as visual acuity improvements and post-surgical complications, should be established. Regular audits can help maintain adherence to the SOPs and identify areas where further training may be required. Feedback from patients should also be collected to understand their experiences and make adjustments that improve patient satisfaction and outcomes.

Post-operative care is a crucial aspect of the program, as proper follow-up is necessary to ensure successful recovery. A structured follow-up system should be implemented, with schedules for checking recovery progress and managing any complications that arise. Access to post-surgery medications, such as eye drops, should be ensured, as well as access to corrective lenses where needed. Engaging community health workers in follow-up visits can improve adherence to recovery plans, especially in remote areas.

Financial accessibility is another critical component. Cataract surgery should be made affordable through subsidized or free services, particularly for low-income populations. Collaborating with NGOs and international donors can help secure the necessary funding. Including cataract surgery in public health insurance schemes can further alleviate financial barriers, allowing broader access to these services.

Finally, continuous evaluation and adaptation are necessary to sustain improvements in cataract care. Evaluating the impact of the program on CSC and eCSC rates, patient outcomes, and cost-effectiveness will help identify successes and areas for improvement. Effective strategies should be scaled up to other regions of Vanuatu, ensuring that the lessons learned contribute to ongoing progress in eye health. By adapting to new insights and feedback, the program can ensure that it remains responsive to the needs of the population and achieves sustainable improvements in cataract surgery outcomes and coverage.

2. Expand Refractive Error Services

Strengthening the provision of refractive error services, including the availability of affordable corrective lenses, can help address the high prevalence of uncorrected refractive errors. Training PHC providers to identify and manage refractive errors can increase coverage and effectiveness. To achieve this, the eye health sector in Vanuatu should work with all relevant stakeholders to:

2.1 Workshop

- Build on findings from the RAAB and focus on understanding barriers to access, the local policy landscape, workforce, manufacturing and supply issues, and information issues. Engage local health leaders and other stakeholders for sustainable progress.

2.2 Enhance Training for Health Workers

- Equip PHC workers with skills for basic vision screenings and empower optometrists with advanced diagnostic training to improve quality and reach.

2.3 Deploy Mobile Clinics for Remote Access

- Use mobile eye clinics to deliver on-the-spot screenings and affordable spectacles in hard-to-reach areas, making eye care accessible for all.

2.4 Improve Supply Chains and Affordability

- Reduce regulation at the point of sale
- Support changes in business models
- Work to reduce import tariffs and custom frictions
- Collaborate with local manufacturers and international partners to provide low-cost, high-quality spectacles, reducing financial barriers.

2.5 Raise Awareness About Eye Health

- Launch targeted campaigns to educate communities on the importance of regular eye exams and the benefits of corrective lenses.

2.6 Implement Rigorous Quality Monitoring

- Establish centralized data systems to track outcomes and maintain high standards through regular audits and feedback from patients.

2.7 Focus on Post-Care Support

- Set up structured follow-up systems to monitor recovery and ensure ongoing support, especially in rural areas.

2.8 Integrate Eye Care into National Health Plans

- Include refractive error services in national health insurance schemes to ensure sustainable access and reduce out-of-pocket expenses for patients.

2.9 Leverage Community Health Workers

- Use community health workers for follow-up visits and patient education, ensuring adherence to corrective measures and continuity of care.

2.10 Continuously Evaluate and Adapt

- Use data-driven insights to adapt programs, expand successful strategies, and ensure that eye care services remain responsive to community needs.

Improving the outcomes and coverage of refractive error services in Vanuatu requires a systematic and systemic approach that aligns with global standards such as those outlined in the WHO's SPECS 2030 initiative. [42] This initiative aims to make refractive error services accessible, high quality, and sustainable across the country, addressing barriers to care and building the capacity of the health system.

The program should begin with a workshop on refractive error. This RAAB survey was a crucial first step in understanding the current refractive error situation in Vanuatu. A workshop focussed on this condition could be held in country to further explore some of the key issues related to eREC; this includes barriers to access, the local policy landscape, workforce, manufacturing and supply issues, and information issues. Engaging key stakeholders, such as local health authorities, community leaders NGOs, WHO, and the IAPB is crucial to align goals and secure commitment for the initiative.

With a clear understanding of the landscape, the next phase focuses on capacity building and workforce development. Training PHC workers to conduct basic vision screenings is a fundamental step. Equipping them with the skills to use visual acuity charts, autorefractors, and other tools endorsed by WHO allows them to identify individuals with refractive errors and ensure timely referrals. Alongside PHC workers, allied ophthalmic personnel need advanced training in diagnostics and the prescription of corrective lenses where appropriate. This ensures that more complex cases can be managed effectively within the local health system. Developing standard SOPs for the screening, referral, and follow-up process ensures consistency across services and maintains a high standard of care.

Expanding service delivery is essential to reach underserved populations, particularly in remote areas. Refractive error services can be integrated into existing NCD clinics in order to reach older adults. This approach makes it possible to screen older adults for presbyopia and other common vision impairments during their regular clinic visits. For remote communities where travel to health facilities is challenging, mobile clinics can be deployed to provide on-site screenings and deliver spectacles directly. These mobile units help bridge the gap in access and bring services to those who need them most. [43]

The analysis of existing evidence identifies three critical areas where efforts could significantly enhance the supply of glasses to underserved populations. A key focus is on revising health policies and regulations surrounding the sale of glasses. Current regulations, including requirements for prescriptions and the roles of different professionals can make obtaining glasses costly and complex. By reconsidering these regulations, there is a potential to reduce costs substantially and improve access. This change could be especially impactful for those needing basic corrective lenses, which make up the majority of cases. Mass-produced, affordable glasses could meet the needs of around 60-80% of people with uncorrected refractive errors. However, such regulatory shifts would need input from medical experts to maintain quality standards, ensuring that the benefits of cost reduction do not compromise care. [43]

In addition to regulatory reforms, leveraging the private sector’s entrepreneurial energy is vital. Governments can play a pivotal role in fostering a more dynamic market for glasses by reducing barriers for new businesses, supporting innovative models for distribution, and facilitating access to development finance. This includes encouraging business models like regional manufacturing and distribution hubs, which can lower inventory costs and extend service reach. Many of these financing opportunities, particularly those from international financial institutions, require government involvement or support. Thus, collaboration between governments, the IAPB, and other NGOs is essential to unlock these resources, strengthen private sector capacity, and ensure a sustainable supply of glasses. [43]

Lowering costs throughout the supply chain is another critical area for improvement, as price sensitivity is a significant barrier for many low-income consumers in low- and middle-income countries. Research suggests that many consumers can only afford glasses priced at about 10% of their monthly income, which often equates to a few dollars. Addressing this challenge involves optimizing the supply chain – using regional hubs for distribution, boosting competition among suppliers, and reducing import costs and tariffs. However, achieving these reductions requires targeted support for governments, especially in navigating international trade laws. By advocating for the treatment of glasses as medical products, it may be possible to minimize tariffs and other costs, thus making glasses more affordable and accessible. [43]

These strategies suggest a multifaceted approach is needed to address the supply-side challenges in the provision of glasses. While regulatory reforms hold the potential for the most significant impact, support for private sector development and supply chain improvements is crucial to ensure affordable and widespread access to corrective eyewear. Collaboration between the IAPB, NGOs, governments, and private companies is key to turning these opportunities into practical solutions that reach the estimated one billion people who currently lack access to necessary vision correction. [43]

Ensuring that spectacles are affordable and available is a critical component of this program. Local manufacturing of low-cost glasses, or partnerships with suppliers who provide affordable options, can ensure that cost does not become a barrier for those in need of vision correction. Subsidy programs, supported by NGOs and international donors, can provide additional financial assistance to low-income populations. Integrating these services into the national health insurance scheme can further alleviate costs, allowing a broader range of people to access necessary corrective lenses.

Community engagement is another vital aspect of the program. Awareness campaigns can be launched to educate the public on the importance of regular eye examinations and the benefits of wearing corrective lenses. WHO has released a toolkit to support the eye health sector in raising awareness of refractive errors, and in particular myopia, in the community. This is called “A toolkit on how to implement MyopiaEd” [44] and provides evidence-based message libraries for education on myopia and its prevention, and operational guidance and resources for implementing and monitoring a national MyopiaEd programme. This toolkit is structured in two parts: Part 1 contains introductions and considerations specific to the development, implementation and monitoring of an MyopiaEd initiative. Part 2 contains general information which relates to any BHBM initiative, including MyopiaEd. This information, e.g. on technology specifications and the role of different stakeholders, is essential for the proper development and implementation of a MyopiaEd initiative

To ensure that improvements in service delivery are sustained, a focus on quality assurance and monitoring is necessary. A centralized data management system should be established to track the coverage of refractive error services, monitor patient outcomes, and identify areas where further training or support may be needed. Regular audits of service delivery, alongside patient feedback, can help maintain high standards and adapt the program to meet changing needs. Collecting and analysing this data allows stakeholders to measure progress, refine strategies, and ensure that services continue to meet the community's needs effectively.

Post-service care, such as follow-up appointments and access to maintenance services like glasses repairs, is also essential to ensure positive outcomes. A structured follow-up system can help monitor patient progress and adherence to prescribed corrective measures. Community health workers can play a key role in these follow-up visits, especially in rural areas, by providing support and encouragement to patients, ensuring they continue using their spectacles correctly.

Financial sustainability is critical for the program's long-term success. By collaborating with NGOs and international donors, the costs of setting up and maintaining services can be managed. Additionally, securing government support to include refractive error services within national health insurance schemes can provide a more sustainable funding model. This ensures that refractive care becomes a permanent part of Vanuatu's health services.

Finally, continuous evaluation is key to adapting the program to the evolving needs of Vanuatu's population. By regularly assessing the impact of the program on eREC rates and patient satisfaction, and making data-driven adjustments, the program can continue to improve and expand. Lessons learned can be applied to other regions, ensuring that improvements in refractive care reach more people and that progress is sustained over time.

3. Continue to Enhance Diabetes Management and Diabetic Retinopathy Screening

Improving diabetes care programs to include regular eye examinations is crucial. Strengthening systematic DR screening and treatment protocols within diabetes management programs can help prevent vision loss among people with diabetes. To achieve this, it is recommended that the eye health sector in Vanuatu work with all relevant stakeholders to:

3.1 Continue to Integrate DR Screening into Diabetes Care

- Leverage opportunities to integrate DR awareness and screening into general diabetes care programs. Health promotion activities for diabetes should include education on the importance of regular eye exams to ensure better coverage of DR screening.

3.2 Use Task-Shifting for Expanded Screening

- Implement task-shifting by training non-ophthalmologist health care staff, such as nurses and community health workers, to perform DR screenings using digital retinal imaging. This can help address the shortage of ophthalmologists in remote areas while maintaining high standards of care.

3.3 Expand Outreach Programs

- Establish outreach services to extend DR screening to rural and remote communities where access to eye care is limited. Use mobile clinics equipped with digital imaging devices and integrate telemedicine for remote diagnosis and follow-up care.

3.4 Focus on Behaviour Change Techniques

- Implement behaviour change interventions like goal-setting and feedback mechanisms for patients to encourage adherence to screening schedules. Educate healthcare providers using evidence-based approaches to strengthen patient engagement and increase screening attendance.

3.5 Promote Cost-Effective Screening Techniques

- Adopt cost-effective screening techniques, such as non-mydriatic digital imaging, which minimizes the need for pupil dilation and speeds up the screening process. This can be particularly useful in primary healthcare settings.

3.6 Strengthen Referral Pathways

- Develop clear referral systems that ensure individuals diagnosed with DR can quickly access specialized care. This includes coordination between diabetes clinics, primary health care providers, and eye specialists to ensure continuity of care.

3.7 Adopt WHO-Recommended Practices

- Follow the WHO's guidance on providing information and support for managing DR risk factors like hypertension and hyperglycaemia. Ensure that this information is integrated into both diabetes and eye care services.

3.8 Evaluate and Adapt Interventions

- Continuously evaluate the impact of these strategies in Vanuatu's local context. Adapt the programs as needed to ensure that they are effective in increasing screening attendance and improving DR management outcomes.

Health promotion campaigns targeting improved awareness of the importance of regular eye examinations and the use of eye care services have been shown to be effective among people with diabetes and health care staff looking after them. However, it should be noted that the evidence available comes mostly from high income countries and should be adapted to the local context and rigorously evaluated for impact in Vanuatu.

A Cochrane Review found that interventions aimed at patients, health care professionals or both, or at the health care system were effective at improving DR screening attendance. Importantly, interventions aimed at improving the general quality of diabetes care worked as well as those specifically aimed at improving screening for DR. This creates opportunities to integrate health promotion activities for DR within diabetes health promotion activities. This is also a significant finding because of the additional benefits of general interventions in terms of improving control of blood sugar levels, vascular risk management, and screening for other microvascular complications. On average, screening attendance increased by 12% compared with no intervention. [45]

The review also found that health promotion interventions were particularly effective where baseline DR attendance was low, which is the case in most low- and middle-income countries, including Vanuatu. A list of behaviour change techniques that were examined is included in the review, along with examples. These should be considered after careful consultation of the Cochrane Review itself, which can be accessed through the Cochrane website. Notably, all behaviour change technique combinations were associated with significant improvements in uptake of screening services, particularly in those with poor attendance. Higher effect estimates were found for the following behaviour change techniques: goal setting (outcome) and 'feedback on outcomes of behaviour' in interventions targeting patients, and 'restructuring the social environment' and 'credible source' in interventions targeting health care professionals. [45] It is likely that further (but smaller) improvements in screening attendance can also be achieved by increasing the intensity of a particular intervention component or adding further components. [45]

The newly developed WHO packages of eye care interventions also recommend providing information and counselling on the importance of the management and control of key risk factors for DR, including hypertension, hyperglycaemia, and hypercholesterolaemia, and appropriate referral, where indicated. [46-48]

An important consideration in low- and middle-income countries, including Vanuatu, is the need to reach rural and remote populations with little to no access to eye health services. Outreach eye care services have been shown to be effective in increasing service coverage in hard-to-reach communities [1, 40, 41]

Outreach services for DR can also integrate task-shifting approaches for the detection of this conditions. Task-shifting for the detection and treatment of DR is explored in more detail below.

DR screening has been shown to be cost-effective when compared to no screening or opportunistic screening. [49-51] However, cost-effectiveness requires high coverage, and this is challenging in low- and middle-income countries. Screening for DR involves an assessment of the retina and it is typically carried out by ophthalmologists. A crucial limitation to the delivery of DR screening in low- and middle-income countries is therefore the low availability and inequitable geographical distribution of ophthalmologists.

The WHO defines task-shifting as the transfer of tasks to existing cadres of health care workers with shorter training and fewer qualifications or to newly created cadres who receive a competency-based

training for the specific task. [52] Task shifting from ophthalmologists to other trained health care staff has been recommended as an approach to improve accessibility of DR screening and reduce burden on ophthalmologists. However, it is crucial that safety and accuracy of screening is maintained. [53, 54]

It is recommended that population-based screening programmes should reach over 80% sensitivity and 95% specificity. [50, 55] That is, at least 80 out of 100 people who are told that they have DR during screening should in fact have the condition. On the other hand, only five or less out of 100 people screened who are told that they *do not have* DR should turn out to have the condition.

There are several factors that can potentially affect the safety and accuracy of task-shifting interventions for DR screening. Firstly, the choice, level and training of the cadre performing the screening is a key consideration and is likely to be different depending on the composition and competencies of the health workforce in a particular country.

Secondly, the screening technique used can also affect the accuracy of the screening. The recommended technique is photography-based screening which adds the possibility of quality assurance. [56] DR screening programs in low- and middle-income countries are gradually adopting retinal photography. However, in many clinics without cameras other methods of retinal examination that are not necessarily effective as screening techniques are still used. [54] This includes direct and indirect ophthalmoscopy; the former involves an eye health specialist using a hand-held ophthalmoscope to look at the retina of patients, and latter involves a specialist typically using a handheld device coupled with another magnifying tool that is attached to a headband. The sensitivity of direct ophthalmoscopy in detecting DR is low (65%) and indirect ophthalmoscopy requires extensive training and experience. [57] Slit lamp bio-microscopy can also be used and has a high sensitivity and specificity, but also requires significant training and the availability of a slit lamp. Optical Coherence Tomography for the detection of diabetic maculopathy is expensive and rarely available outside tertiary level eye departments in low- and middle-income countries.

Thirdly, the use of drops to dilate the pupils – referred to as mydriasis – can improve effectiveness of task-shifting by increasing the number of gradable images. [54] However, non-mydriatic screening presents several advantages, like reduced screening time, less inconvenience for patients, and importantly no limitations for using cadres that may not be allowed to instil eye drops.

The recently released WHO packages of eye care interventions recommend the provision of Anti-Vascular Endothelial Growth Factor (VEGF) therapy for the treatment of vitreoretinal disorders, including DR. [46, 48, 58]

While intravitreal anti-VEGF is considered the gold standard in the treatment of a range retinal disorders, cost implications currently limit its availability in many low- and middle-income countries. There are several promising developments in this area that offer potential to reduce the treatment costs of anti-VEGF in the future. The rising number of intraocular injections, expected to continue according to projections of the increase in the elderly population, is also becoming a challenge for ophthalmology departments worldwide, and to the provision of truly IPEC. Much as it is the case for DR screening, task shifting to nurse-administered injections may alleviate this burden. [59] This practice is not yet widespread, however a recent randomized controlled trial concluded that ask shifting of intraocular injections to nurses can be performed without increased risk to visual function. [60] This trial supports a growing body of evidence, which demonstrates that – with the correct training and protocols in place – intravitreal injections administered by nurse practitioners are as safe as ophthalmologist-delivered services. Such a task shift can alleviate the burden of performing intraocular injections in ophthalmology

departments and, importantly, increase accessibility of treatment by bringing this closer to patients. [60] It should be noted, however, that the existing evidence is from high-income countries and adaptation and testing of such task-shifting practices in resource-constrained settings should be carried out before large-scale roll out.

There are numerous examples from around the globe of the integration of DR screening within primary health care services and or/diabetes services, which rely on task shifting from ophthalmologists to other (allied) health care staff.

These provide moderate evidence that non-ophthalmologist cadres can accurately screen and grade DR. The majority of available evidence is for optometrists, with some evidence of accuracy being comparable to ophthalmologists, and some evidence of optometrist having lower specificity pointing to a significant number of false positives.

There is also evidence of other cadres being successfully trained to perform DR screening, including novices with no previous health training.

The choice of cadre is likely to be contextual and to depend on previous training and their accuracy is likely to depend on the additional training given to perform DR screening. Retinal imaging with digital cameras is the technique of choice in most studies and likely facilitates task-shifting of DR screening. A study that investigated whether technicians could diagnose DR using direct ophthalmoscopy reported poor results.

It should be noted that task-shifting should not happen in isolation, but rather it should only be implemented with a health systems that has strong coordination and collaboration within and across levels of the health care system, and which can ultimately ensure that those who are found to have sight threatening DR can access *and* complete treatment.

Outreach services delivered by non-ophthalmologists can also be an answer to this problem, but evidence suggests that accuracy is higher in hospital-based screening services compared with outreach services. [61] Nonetheless, several approaches for DR screening in outreach services that can lend themselves to task-shifting have shown promising accuracy levels. These include telemedicine using digital imaging, the use of artificial intelligence supported cameras or smart phone-based technology for image capture. [62-66]

4. Integrate Eye Health into Primary Health Care

Implementing integrated people-centred eye care (IPEC) as recommended by the World Health Organization and the IAPB can ensure that eye health services are accessible, affordable, and equitable. Training for PHC workers in eye care can enhance early detection and treatment of eye conditions. Strengthening of PHC system, to ensure that people seeking help have access to eye services. To achieve this is it recommended that the eye health sector in Vanuatu work with all relevant stakeholders to:

4.1 Strengthen PHC Integration

- Prioritize the integration of eye care services, such as DR screening and refractive services, into existing primary healthcare systems to increase accessibility. This approach ensures that a larger portion of the population can access basic eye care services throughout their life course.

4.2 Build Capacity with Targeted Training

- Invest in training primary healthcare providers in essential eye care skills, such as visual acuity testing and basic retinal assessments. This will allow more effective early detection of eye conditions like diabetic retinopathy (DR) and cataracts, leading to timely referrals.

4.3 Develop Effective Referral Systems

- Establish clear and efficient referral pathways between PHC centres and specialized eye care services. This helps ensure that patients who need more complex care, such as cataract surgery or advanced DR management, are referred without delay.

4.4 Focus on Community-Based Eye Care Models

- Implement mobile and community-based eye care initiatives, particularly in remote and underserved regions. This can help to provide services closer to people's homes, reduce travel costs, and improve access for those living far from fixed facilities.

4.5 Leverage Technology for Screening

- Utilize digital tools such as retinal photography, smartphone applications, and telemedicine to improve the accuracy and reach of screening services. This can also support task-sharing models where trained non-specialist staff conduct initial screenings.

4.6 Ensure Adequate Funding and Resources

- Secure funding for eye care integration into PHC through national budgets and international donors. This funding should cover training programs, the purchase of essential equipment, and the establishment of mobile clinics.

4.7 Promote Health Education Campaigns

- Launch awareness campaigns on the importance of regular eye check-ups, particularly for those with diabetes or other conditions that increase the risk of vision loss. Culturally appropriate messages delivered through community channels can increase participation in eye care services.

Reorienting the model of care involves ensuring that efficient and effective health-care services are designed and provided by means of innovative models of care that prioritize primary and community care services and the co-production of health. Strong primary healthcare, with integrated eye care, is important since eye care involves both the delivery of interventions aimed at the individual through primary care (e.g. DR screening) and population-based interventions. [1]

Strengthening eye care in PHC requires adequate funding, appropriate workforce training, a sustainable workforce, [67] coordination with other services and sectors, and effectively-planned referral systems. When sufficiently resourced, PHC can meet a large number of people's eye care needs throughout their life course and can raise awareness of the importance of maintaining eye health and eye disease prevention behaviours.

Services for DR, refractive services for adults, case-finding of common eye conditions, such as cataract, and the diagnosis and management of some common eye conditions that do not typically cause vision impairment, such as conjunctivitis, can also be provided within PHC. [68] In situations where more specialized services are required – for example after the detection of cataracts or DR – primary care can facilitate referrals and coordination across providers and care settings.

There is no single path any country should follow to achieve a strong primary care that includes eye care. That path may include the integration of primary eye care services within PHC centres, achieved through enhanced supervision and the training of existing staff, or the adoption of standalone primary eye care services, either in fixed facilities or through mobile units. While technical guidance is not yet available on how to move forward in building a strong primary care specific to the eye care sector, the documents, *A vision for primary health care in the 21st century* [67] and the WHO Technical Series on *Safer Primary Care* [69] offer useful resources.

In order to fully implement effective measures to prevent and treat eye health conditions and other NCDs across the life course, health systems need to be based on a solid primary health care network accessible to all under the principle of UHC.

Primary health care can increase the accessibility of services and it is critical to sustainably address other key components of universal health care such as: (i) reducing household expenditure by emphasizing population-level services that prevent eye conditions and promote early detection and timely referral; and (ii) reaching remote and disadvantaged populations through a focus on community-based services that are provided as close as feasible to people's homes. [1, 67]

PHC settings can be used to provide screening services for common eye conditions such as DR, cataract, refractive errors, and DR [1, 68] as well as for the diagnosis and management of some common eye conditions that do not typically cause vision impairment, such as conjunctivitis.

In a low or intermediate resource settings, the minimum examination components to assure appropriate referral should include a screening visual acuity exam and retinal examination adequate for DR classification. Vision should be tested prior to pupil dilation

The screening vision exam should be completed by trained personnel in any of the following ways, depending on resources:

- Refracted visual acuity examination using a 3- or 4-meter visual acuity lane and a high contrast visual acuity chart – alternatively, a smartphone mobile application endorsed by WHO may be used.
- Presenting visual acuity examination using a near or distance eye chart and a pin-hole option if visual acuity is reduced.
- Presenting visual acuity examination using a 6/12 (20/40) equivalent handheld chart consisting of at least 5 standard letters or symbols and a pin-hole option if visual acuity is reduced.

A retinal examination may be accomplished in the following ways:

- Direct or indirect ophthalmoscopy or slit-lamp biomicroscopic examina of the retina.
- Retinal (fundus) photography (including any of the following: widefield to 30o; mono- or stereo-; dilated or undilated).This could be done with or without accompanying optical coherence tomography (OCT) scanning. This could also include telemedicine approaches.

For the retinal examination, a medical degree may not be necessary, but the examiner must be well trained to perform ophthalmoscopy or retinal photography and be able to assess the severity of DR.

Using adequate information from the visual acuity and retinal examinations, one can decide on an appropriate management plan. The plan may be modified based on individual patient requirements. Patients with less than adequate retinal assessment should be referred to an ophthalmologist unless it is obvious that there is no DR, or at most, only mild non-proliferative DR (i.e., microaneurysms only). In addition, persons with unexplained visual-acuity loss should be referred.

As part of a screening exam, persons with diabetes should be asked about their diabetes control, including blood glucose, blood pressure, and serum lipids. In addition, women should be asked if they are or could be pregnant. Inadequate control and pregnancy may require further appropriate medical intervention.

Minimum referral guidelines are as follows:

- Visual acuity below 6/12 (20/40) or symptomatic vision complaints
- If DR can be classified according to the simplified International Classification of DR, they should be referred accordingly
- If visual acuity or retinal examination cannot be obtained at the screening examination: refer to ophthalmologist.

5. Public Awareness and Health Promotion

Conducting public health campaigns to raise awareness about the importance of eye health, the availability of services, and the need for regular eye examinations, particularly for those with diabetes, can help increase the uptake of eye care services. To achieve this is it recommended that the eye health sector in Vanuatu work with all relevant stakeholders to:

5.1 Enhance Public Health Campaigns

- Raise awareness about eye health and regular eye exams, especially for those with chronic conditions like diabetes, to boost service uptake and outcomes.

5.2 Promote Patient-Centred Care

- Empower patients through education and support, improving their understanding of health conditions and treatments for better management and self-care.

5.3 Improve Health Literacy

- Increase eye health literacy, focusing on populations with lower literacy levels (e.g., elderly, rural communities) to enhance adherence to eye exam guidelines and outcomes.

5.4 Integrate Refractive Error Awareness into Broader Health Initiatives

- Utilize existing health programs to promote refractive error management, emphasizing lifestyle changes like reducing near work and increasing outdoor time to manage myopia.

5.5 Provide Community-Based Education

- Deliver eye health information through community settings, using primary and secondary health care systems for consistent messaging on prevention and management.

People and community engagement and empowerment lead to better health outcomes, better care, better patient experience, and lower costs to health systems. Engaged and empowered patients can make informed decisions and are better able to seek health services and appropriate interventions if they understand health information and treatment options. [69] Patient-centred care, engagement, and empowerment include involving patients and their families in self-management of chronic diseases. However, patients can be limited by low health literacy, leading to less effective self-care and worse health outcomes. [70]

As outlined in the World Report on Vision, poor eye health literacy is indeed associated with suboptimal adherence to eye examination guidelines, and poorer eye health outcomes. [1, 71-73] There is evidence that health literacy has an impact on management of a number of eye health conditions, including cataract, [74] refractive error, [75] and glaucoma. [76] Lack of knowledge of the availability of services has also been identified as a barrier to eye care use among the elderly [77] and other high-risk populations. [1, 78-80] In addition, vision impairment may represent an underrecognized, independent risk factor for poor self-management. [70, 81] This suggests that attention to health literacy may improve the care and outcomes of people with vision loss.

Condition-specific health promotion strategies are detailed in the other recommendations. Nonetheless, Targeted campaigns should be implemented to raise awareness about eye health, the availability of eye care services, and the importance of regular eye exams, particularly among those with chronic conditions like diabetes. The uptake of services can be increased, and outcomes can be improved through these efforts.

Patient engagement and empowerment should be encouraged through education and support, allowing individuals to better understand their health conditions and the available treatments. Improved management of chronic conditions and enhanced self-care practices can be achieved as a result.

A focus should be placed on boosting eye health literacy to ensure better adherence to eye examination guidelines and to achieve improved health outcomes. Programs should be tailored to reach populations with lower literacy levels, such as the elderly and those in rural areas, to ensure that barriers to accessing care are reduced.

Existing health programs should be used to promote awareness of refractive error management, with an emphasis on lifestyle changes like reducing intensive near work and spending more time outdoors to help manage and prevent conditions such as myopia.

Community-based education should be provided by using community settings to deliver information on eye health, leveraging primary and secondary health care systems to ensure consistent messaging on the prevention and management of eye conditions.

The newly developed WHO packages of eye care interventions also recommend providing information lifestyle risk factors, including intensive near vision activity (as a risk factor) and longer time spent outdoors (as a protective factor), in the onset and progression of myopia, and prevention of high myopia. [82] This information can be provided within community settings, but also at primary and secondary levels of the health care system.

6. Strengthen Health Systems

Building the capacity of health systems to support eye care services, including infrastructure, human resources, and supply chains, is essential for sustainable improvements. Ensuring that eye health is integrated into national health plans and budgets is also critical. To achieve this is it recommended that the eye health sector in Vanuatu work with all relevant stakeholders to:

6.1 Strengthen Policy Support for Eye Care Integration

- Advocate for policies that support integrated, people-centred approaches to eye care to enhance access and quality.
- Foster partnerships with global stakeholders to align national priorities.

6.2 Ensure Availability and Proper Use of Essential Medicines for Eye Care

- Collaborate with health ministries to update essential medicine lists.
- Support governments in procuring essential medicines, especially for low- and middle-income groups.

6.4 Build Capacity for Evidence-Based Health System Strengthening

- Establish health information systems for effective eye health data collection and analysis.
- Promote the use of disaggregated data for better decision-making and equity.
- Train healthcare providers to deliver evidence-based care.
- Use data to identify gaps, target interventions for high-need populations, and track progress on eye health goals.
- Collect data on key indicators such as eCSC, eREC, and DR services.
- Advocate for integrating eye health data into national systems for improved monitoring and resource allocation.

6.5 Enhance Training and Support for Health Workforce

- Upskill healthcare providers for effective eye care aligned with WHO guidelines.
- Offer continuous training to keep providers updated.
- Encourage mentorship across regions to build skills.

6.6 Enhance Collaboration and Coordination

- Support coordinated, patient-cantered care across all levels of health care.
- Ensure seamless transitions for patients through coordinated services..

6.7 Strengthen Referral Pathways

- Develop evidence-based referral systems for better coordination.
- Use strategies like education, counselling, and follow-up reminders to improve referral compliance.

Policy-based support is crucial for integrated, people-centred approaches to eye care to be successful and sustainable. This is covered in more detail in Recommendation 7.

The WHO defines essential medicines as those medicines that respond to the priority health needs of a specific population. Essential medicines should be available at all times in adequate amounts, in appropriate dosage forms, and be cost effective. To respond effectively to a population's health needs, they must also have a proven efficacy, quality, and safety. When respecting these criteria, essential medicines are one of the most cost-effective elements for any health system, with an immediate and long-lasting health impact. Despite this health impact – and despite a thriving medicines market – there

remain critical problems with essential medicines in low- and middle-income countries. They are often not easily available or accessed, they can be unaffordable and of poor quality, and they are used inappropriately.

The IAPB collaborates on the development of a series of 'IAPB Essential Lists' to assist Ministries of Health, district health services, eye clinics and hospitals, and non-state actors in decision-making. These lists are a useful resource to assist in planning and purchasing inventory to support the delivery of quality care and in doing so enhance eye health outcomes. [83]

Sound and reliable information is the foundation of decision-making across all health system building blocks. It is essential for: i) policy-makers to identify and respond to problems with evidence-based solutions and to allocate resources effectively; ii) planners to design more effective services, and managers to monitor and evaluate these services; and iii) clinicians to provide high quality and evidence-based care. [84]

Applied to eye care and with the objective of moving towards IPEC, information should be collected about: i) the determinants of eye conditions; ii) the capacity of the health system to provide eye care services as well as its performance – in particular, how well existing eye services address population needs in an equitable manner; and iii) the numbers of individuals with eye conditions and vision impairment, and their level of functioning and well-being. [1] It is also crucial that the data collected and used is appropriate for the stated purpose, of high quality, and available in formats that meet the needs of multiple users.

Too often the complexities of developing a useful health information system are underestimated and the outcome is a poorly implemented and under-utilised system, as well as the duplication of data entry efforts. Developing and effectively implementing a functional health information system within health care provider settings represents a substantial sociotechnical challenge, let alone doing so at the sub-national or national level. First, a health information system must be designed and developed in such a way that it supports user goals and workflows, and governments and/or health care providers must configure the relevant information technology correctly and safely. Second, the system must be used correctly and completely by all health care providers as they care for their patients, and relevant information needs to be fed up the health care system all the way to relevant ministries. Third, health care organizations must work in conjunction with their electronic health record vendors to monitor and optimize this technology to enable it to help them identify, measure, and improve the quality and safety of the care provided. [85]

Sittig and colleagues [85] identify nine key challenges that health care organizations, health information technology developers, researchers, policymakers, and funders must focus on to implement health information technology efficiently and safely. These challenges relate to (1) developing models, methods, and tools to enable risk assessment; (2) developing standard user interface design features and functions; (3) ensuring the safety of software in an interfaced, network-enabled clinical environment; (4) implementing a method for unambiguous patient identification; (5) developing and implementing decision support; (6) identifying practices to safely manage information technology system transitions; (7) developing real-time methods to enable automated surveillance and monitoring of system performance and safety; (8) establishing the cultural and legal framework/safe harbor to allow sharing information about hazards and adverse events; and (9) developing models and methods for consumers/patients to improve health information technology. The authors note that these challenges represent key "to-do's" that must be completed before we can expect to have safe, reliable, and efficient health information technology–based systems required to care for patients.

Information should include the numbers of individuals with eye conditions and vision impairment, and their level of functioning and well-being. In line with WHO recommendations, Vanuatu should consider collecting eCSC and eREC. Notably, in 2021 the 74th World Health Assembly endorsed the global targets for eREC and eCSC to be achieved by 2030 - namely, a 40 per cent increase in coverage of refractive errors and a 30 per cent increase in coverage of cataract surgery. These targets will play a key role in increasing global eye care coverage in the future while delivering quality services. [29]

Information on the capacity of the health system to provide eye care services as well as its performance are also required. This information is typically collected using health information systems at the health provider setting. Below are some key indicators relating to DR services.

The United Kingdom National Health Service developed 13 indicators and standards to monitor and continuously improve the performance of DR screening and referral services. These comprise three key performance indicators and targets and ten additional indicators and targets.

IPEC requires eye care to be delivered at all levels of the health care system and by both generalist health care providers and specialist eye health personnel. Accordingly, IPEC requires comprehensive planning of the eye care workforce, inclusive of all health workers involved at the entry point of health care (primary care), and based on an in-depth analysis of the health labour market in general. [1] The figure below provides an outline of the generalist and specialist health care workforce required for the delivery of IPEC. [86]

COMMUNITY BASED	**FACILITY BASED**					
Generalist health care providers (eye health competencies included in general training)	Specialist eye health personnel (special or advanced eye health training)					
	Allied ophthalmic personnel					
Community health workers	Front line health workers & primary health care providers	(Ophthalmic) Assistants (Medical assistants)	(Ophthalmic) Nurses (Nurse professionals)	(Ophthalmic) Clinical officers, etc. (Paramedical practitioners)	Optical dispensers & orthoptists	Optometrists & Ophthalmologist

Adapted from [86]

Generalist health care is typically provided at the primary care level. This is vital for the implementation of IPEC, however it is necessary for the primary care personnel to have the competencies required to provide eye care interventions – particularly those for early identification and referral to specialized eye care as appropriate. [1] Allied ophthalmic personnel are a heterogeneous group of staff with specialist ophthalmic training. In contrast to ophthalmologists and optometrists, allied ophthalmic personnel often serve in rural areas. [87] They work in interdisciplinary teams to receive patients with eye conditions. The patients are sent to them directly or referred from primary and community health workers.

Realizing IPEC requires a competency-based care approach to workforce planning. Competencies refer to the specific tasks an individual must be able to perform to a specified standard to qualify as a professional. Competences are needed for different interventions, and health workers with appropriate competences and skills will be required at each service delivery level. The WHO developed an Eye Care Competencies Framework to improve the distribution of skills in the eye team. [88]

The Framework is a tool that conveys the expected or aspired performance of the workforce across primary to tertiary levels of care, to enable quality care and service delivery that meet the need of the population. The framework includes both *how* an eye care worker behaves and *what* an eye care worker does. The framework outlines competencies for six domains that are relevant to eye care workers: Practice, professionalism, learning and development, management and leadership, community and advocacy, and evidence. These are explored in more detail, below.

- Practice: competencies related to the eye care worker's interaction with people, where care is delivered through a people-centred practice. It includes competencies necessary for establishing a therapeutic relationship, assessment, planning, delivering interventions, communication and clinical decision making. These competencies are linked with the Package of Eye Care Interventions
- Professionalism: competencies related to ethical, safe, high quality, efficient, and effective best practice care. It includes values such as integrity, inclusivity, respect for diversity, social and environment awareness, and transparency with potential conflicts of interest.
- Community and advocacy: Competencies related to advocating the needs of the community, supporting members to be empowered to access available resources, and contributing to long term beneficial change.
- Management and leadership: competencies related to service development, resource management and team leadership.
- Community and advocacy: Competencies related to advocating the needs of the community, supporting members to be empowered to access available resources, and contributing to long term beneficial change.
- Evidence: competencies related to the use, generation of, contribution to, and dissemination of evidence for eye care interventions, services and systems

For each of these six domains, the framework not only outlines competencies, but also relevant behaviours, activities, tasks, and knowledge and skills.

In addition to understanding the competencies required and what (eye) health care staff may be best placed to performed specific tasks, countries need comprehensive assessments on the availability and distribution of health workers with the necessary skills. This, in turn, requires a function health information system. At the WHA in May 2016, and as part of the global strategy on human resources for health, Member States were urged to implement progressively the National Health Workforce Accounts (NHWA). [89] WHO has developed overall guidance and a series of NHWA tools to improve, over time, the availability, quality and use of data through monitoring standardized indicators on health workforce. With improved data through NHWA, health labour market analysis can be conducted, and can facilitate the understanding of eye care workforce dynamics which involves the assessment of the supply and demand of health workers involved in eye care. [1]

Finally, delivery of IPEC that includes (eye) health workforce at all levels of the health care system needs to be enabled by adequate training programs and policies. These policies include regulations on staff training, service quality, and dual practice, to ensure equitable access to quality health services for the entire population. [1]

Historically the eye health sector has operated independently, and coordination and collaboration with other sectors have been key issues for the eye health system across the world. [1]

Truly integrated, patient-centred care that meets the needs of older people will require a coordinated approach across the healthy ageing, diabetes, primary, secondary, and tertiary health care. It will require those responsible for the provision of care at each level of the health care system to take ownership of the services they provide to address eye health while supporting other points of care to do the same, ensuring continuity and effective linkage along the care pathway. [90]

Effective referral systems linking people with diabetes with different services within and across levels of care are critical to enable both the continuum and necessary quality of care. [91] In an ideal health system, a referral would result in a swift, completed consultation, with appropriate communication between the patient, the referring facility, and the receiving facility. These facilities can be within the same levels of the health care system (for example, between the endocrinology and ophthalmology units of a secondary level hospital) or across levels of the health care system. Effective referral systems are critical both within and across levels of the health care system.

The effectiveness of referral systems depends on multiple factors that involve patients, health care workers, and other stakeholders. Each stakeholder is dependent on the other and could form either a barrier or a facilitator of referral. [92, 93] This is particularly important for DR. Despite the benefits of timely DR services, the DR referral process in many settings means DR services remain inaccessible to large portions of the population, as well as an inability to track referred patients. [94, 95]

Evidence-based strategies to increase successful referral rates for DR services in low- and middle-income countries are limited and can be divided into two categories. There are interventions to encourage positive patient behaviour towards uptake and provider's level measures oriented to educate staff on the importance of referrals and train them in counselling patients. Patient-focused actions included direct health education strategies for DR patients attending screening and media broadcasts in radio and television targeting the general population. Direct strategies included educational materials, posters and brochures as well as educational talks and "diabetic diaries". Face to face patient counselling at the time of referral followed by telephone reminders has been shown to be effective in increasing compliance to referrals in one randomised controlled study. [96] Other methods to communicate the referral appointment included text message, phone call and postcards. At the provider's level measures included training of eye health personnel on DR patient counselling and the distribution of a DR manual to all staff.

7. Policy and Advocacy

Successful implementation of the recommendation above must be underpinned by effective advocacy efforts. These should continue to focus on ensuring that eye health is a priority in national health policies and budgets, with adequate funding allocated to support comprehensive eye care programs. Emphasizing the economic and social benefits of investing in eye health services can help garner support from policymakers and international donors. To achieve this is it recommended that the eye health sector in Vanuatu work with all relevant stakeholders to:

7.1 Strengthen Advocacy for Eye Health:

- Advocate for eye health to be prioritized in national health policies and budgets.
- Highlight the economic and social benefits of investing in eye health to gain support from policymakers and donors.

7.2 Integrate Eye Health into National Health Strategies:

- Ensure eye care is included in health strategic plans for better planning and budgeting.
- Define clear goals and responsibilities for achieving eye health objectives.

7.3 Support Policy-Based Approaches:

- Formalize task-shifting for DR detection and treatment through regulation and budget inclusion.
- Focus on health systems strengthening for sustainable eye care interventions, beyond a single-disease approach.

7.4 Foster Inter-Sectoral Collaboration:

- Enhance coordination between health ministries and other sectors, such as diabetes care.
- Build partnerships with NGOs and private organizations for effective implementation and monitoring of eye health initiatives.

Formulating national policies and strategies is a basic function of governments, and the task of formulating and implementing a health policy falls within the remit of the health ministry. Too often, however, eye care is not included in health strategic plans. It can be assumed that if eye care is not included in health strategic plans, it will frequently not be included in the planning and budgeting of services either. [1]

National health strategies and policies should integrate eye health and eye care. They should outline eye health priorities based on demonstrated need, they should define goals, and outline how objectives for eye health will be achieved. Importantly, strategies and policies should also outline expected roles of different actors, inform and build consensus, and estimate the resources required to achieve these goals and priorities. This is particularly important if a truly integrated and coordinated approach among sectors is to be achieved, for example between the diabetes and eye health sectors.

For example, implementation of task-shifting approaches to the detection and treatment of DR must be formally recognised, approved, and regulated if they are to move beyond the realm of pilots and are to be included in health budgets and health financing approaches. Similarly, policy-based support with a focus on health systems rather than a focus on a single disease is crucial for refractive error interventions to be sustainable. [97] The level of collaboration between ministries may either facilitate or inhibit the coordination and success of interventions. [97] Since achieving shared responsibility of the monitoring and execution of policies targeting eye health is considered important in the success of eye-care interventions in low- and middle-income countries, partnerships between ministries and nongovernmental or private organizations are considered crucial. [97]

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APPENDIX 1. SELECTED ENUMERATION AREAS

On 41 occasions the data collection teams had to complete data collection for a cluster in the nearest village or had to swap a selected cluster for the nearest village altogether. Out of these, 31 clusters did not have enough people aged 50 years and older and eight clusters could not be accessed because of road and weather conditions. Two clusters were found to be uninhabited.

NAME	CODE	PROVINCE	ISLAND	REPLACEMENT CLUSTER
Batambong	13110009	Malampa	Malekula	Lingarak
Bonvor	13110015	Malampa	Malekula	leviamp
Dixon reef	13110019	Malampa	Malekula	
Fali	13110028	Malampa	Ambrym	
Fantan	13110029	Malampa	Ambrym	
Harimal	13110034	Malampa	Ambrym	
Lavalsal	13110051	Malampa	Malekula	
Limap	13110056	Malampa	Malekula	
Lulep	13110065	Malampa	Paama	
Mae	13110066	Malampa	Malekula	
Other village_(999933) (farun)	13110095	Malampa	Malekula	Unmet
Other village_(999936) (moru)	13110096	Malampa	Ambrym	
Ranon	13110109	Malampa	Ambrym	
Rory	13110111	Malampa	Malekula	
Sanesup	13110112	Malampa	Ambrym	Sisivi
Tevri	13110129	Malampa	Urivip	
Vaoleli	13110134	Malampa	Paama	
Veturah	13110135	Malampa	Malekula	
Vinmavis	13110136	Malampa	Malekula	
Abwantuntora	13110001	Penama	Pentecost	
Ambanga	13110003	Penama	Ambae	Lolopue & Lolovange
Anmalabua	13110004	Penama	Pentecost	Amatpopo
Asanvari	13110005	Penama	Maewo	
Avantavoa	13110006	Penama	Pentecost	Loltong
Baitora	13110008	Penama	Maewo	Kerebei
Bunlap	13110016	Penama	Pentecost	Wanur& Ranputor
Lemalda	13110053	Penama	Pentecost	
Loigememea	13110057	Penama	Ambae	Lolovenue
Lolotari	13110058	Penama	Ambae	Lovunvili
Londar	13110059	Penama	Pentecost	
Lovatumemea	13110063	Penama	Ambae	Navonda
Mandiri	13110068	Penama	Maewo	Nasawa
Navitora	13110085	Penama	Ambae	
Nokontawen	13110087	Penama	Pentecost	
Other village_(999921) (saranamoli)	13110094	Penama	Ambae	Walaha & Vilakalaka
Ponra	13110105	Penama	Pentecost	Point Cross
Sarinlang	13110114	Penama	Pentecost	Tansip

NAME	CODE	PROVINCE	ISLAND	REPLACEMENT CLUSTER
Waidumi	13110137	Penama	Ambae	
Wanbukelan	13110138	Penama	Pentecost	Enar
Avunarani	13110007	Sanma	Malao	
Chapuis 1	13110017	Sanma	Santo	
Chapuis 2	13110018	Sanma	Santo	
Kona	13110044	Sanma	Santo	
Lebathi	13110052	Sanma	Santo	Enkul
Lethesi	13110055	Sanma	Santo	Port Olry Sector 3 &4
Lorevulko	13110060	Sanma	Santo	Hoghabor
Mango station	13110069	Sanma	Santo	
Na 202010 (talantas)	13110076	Sanma	Santo	Matantas
Na 205013 (sara 3)	13110077	Sanma	Santo	Sara 1 & 2
Namalo	13110079	Sanma	Santo	Narango
Naonetas	13110083	Sanma	Santo	
Natanowaha	13110084	Sanma	Malo	
Other village_(999913) (mavunlef)	13110092	Sanma	Santo	Nambauk
Other village_(999915) (cahpius 3)	13110093	Sanma	Santo	Maniok & Natawa
Pelvus	13110102	Sanma	Santo	Kole 2 & Totkar
Pepsi sarakata	13110103	Sanma	Santo	
Picarde	13110104	Sanma	Aore	Tutuba
Port olry	13110106	Sanma	Santo	Port Olry Sector 1 &2
Sarakata	13110113	Sanma	Santo	
Show ground	13110116	Sanma	Santo	
Solomons hill	13110119	Sanma	Santo	
Tanavoli	13110123	Sanma	Santo	Namoru
Tolomako	13110130	Sanma	Santo	
Valankara	13110133	Sanma	Santo	
Wong plantation	13110139	Sanma	Santo	Fanafo
Wunpuku	13110140	Sanma	Santo	Kole 1
Agathis	13110002	Shefa	Efate	
Beverly hills	13110011	Shefa	Efate	
Blacksands (efate)	13110012	Shefa	Efate	
blacksands 2 (efate)	13110013	Shefa	Efate	
Bladiniere estate	13110014	Shefa	Efate	
Ellouk	13110020	Shefa	Efate	Pango 1
Erakor	13110022	Shefa	Efate	
Erakor 2	13110023	Shefa	Efate	
Erakor 3	13110024	Shefa	Efate	
Erangorango	13110025	Shefa	Efate	
Eratap hafrod	13110026	Shefa	Efate	
Etas	13110027	Shefa	Efate	
Foreland	13110030	Shefa	Epi	
Freswota 2	13110031	Shefa	Efate	
Freswota 4	13110032	Shefa	Efate	
Freswota 6	13110033	Shefa	Efate	

NAME	CODE	PROVINCE	ISLAND	REPLACEMENT CLUSTER
Ifira	13110036	Shefa	Efate	
Independence park	13110039	Shefa	Efate	
Itakoma	13110041	Shefa	Tongoa	
La mine	13110045	Shefa	Efate	
Lamenu bay	13110048	Shefa	Epi	
Malapoa estate	13110067	Shefa	Efate	
Maturu	13110071	Shefa	Lelepa	
Mele	13110072	Shefa	Efate	
Mele 2	13110073	Shefa	Efate	
Melemaat	13110074	Shefa	Efate	
Metano	13110075	Shefa	Epi	Sola
Na 513060 (nambatu)	13110078	Shefa	Efate	
(nambatri)	13110080	Shefa	Efate	
Namburu	13110081	Shefa	Efate	
Namburu 2	13110082	Shefa	Efate	
Ngalovasoro	13110086	Shefa	Lamen Island	
Nul nessa	13110088	Shefa	Epi	
Ohlen	13110089	Shefa	Efate	
Ohlen mataso	13110090	Shefa	Efate	
Oreau	13110091	Shefa	Epi	
Other village_(999949) (melektri)	13110097	Shefa	Efate	Switi
Pang pang	13110099	Shefa	Efate	
Pango esnar	13110100	Shefa	Efate	
Paonangisu	13110101	Shefa	Efate	
Prima	13110107	Shefa	Efate	
Rentabao	13110110	Shefa	Efate	
Seaside	13110115	Shefa	Efate	
Simbolo	13110117	Shefa	Efate	
Snake hill	13110118	Shefa	Efate	Mangaliliu
Stade	13110120	Shefa	Efate	
Sunae	13110121	Shefa	Moso	
Tagabe bridge	13110122	Shefa	Efate	
Tanoliu	13110124	Shefa	Efate	
Tasiriki (vila)	13110125	Shefa	Efate	Manples
Tebakor	13110126	Shefa	Efate	
Teouma bush	13110127	Shefa	Efate	
Teoumaville	13110128	Shefa	Efate	
Bethel (tanna)	13110010	Tafea	Tanna	
Eniai	13110021	Tafea	Tanna	
Ianemra	13110035	Tafea	Tanna	Green Point
Ikurup	13110037	Tafea	Tanna	
Imarae	13110038	Tafea	Futuna	
Ipota	13110040	Tafea	Erromango	
Kalali	13110042	Tafea	Tanna	
Kings cross	13110043	Tafea	Tanna	

NAME	CODE	PROVINCE	ISLAND	REPLACEMENT CLUSTER
Laimira	13110046	Tafea	Tanna	Green Hill
Lamakawin	13110047	Tafea	Tanna	
Lanimlelang	13110049	Tafea	Tanna	
Laruanu	13110050	Tafea	Tanna	
Lenoakas	13110054	Tafea	Tanna	
Loukatai	13110061	Tafea	Tanna	
Lounapkau langis	13110062	Tafea	Tanna	
Lownasunan	13110064	Tafea	Tanna	
Other village_(999960) (louniparu)	13110098	Tafea	Tanna	
Unorah	13110132	Tafea	Erromango	
Yanumakel	13110141	Tafea	Tanna	
Yenemaha	13110142	Tafea	Tanna	
Mariu	13110070	Torba	Mota	Mota & Rah
Qeremade	13110108	Torba	Motalava	
Tukwetap	13110131	Torba	Mota	Avar

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