The Social and Economic Impact of Refractive Error in Mozambique

Stephen James Thompson
Technological University Dublin

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The social and economic impact of refractive error in Mozambique

Name
Stephen James Thompson MSc BSc

Award sought
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Institution
Dublin Institute of Technology

School
School of Physics

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Supervisors
Prof James Loughman (Dublin Institute of Technology, Ireland)
Prof Kovin Naidoo (University of KwaZulu Natal, S. Africa)
Prof Geoff Harris (Durban University of Technology, S. Africa)
I certify that this thesis which I now submit for examination for the award of PhD, is entirely my own work and has not been taken from the work of others, save and to the extent that such work has been cited and acknowledged within the text of my work.

This thesis was prepared according to the regulations for postgraduate study by research of the Dublin Institute of Technology and has not been submitted in whole or in part for another award in any other third level institution.

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Signature:  
Date: 15 January 2015
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Dedication

My father, Francis Thompson (1948 – 2014), gave me so much encouragement to start my research, but sadly died before I could finish it. As a man who valued education so highly, this thesis is dedicated to him.

Hold on to instruction, do not let it go; guard it well, for it is your life. Proverbs 4:13
Abbreviations List

ARMD - Age Related macular degeneration
BCR - Benefit Cost Ratio
CBA - Cost Benefit Analysis
CEA – Cost Effectiveness Analysis
CMA - Cost Minimisation Analysis
CUA - Cost Utility Analysis
DALY – Disability Adjusted Life Year
DW - Disability Weight
DIT – Dublin Institute of Technology, Republic of Ireland
ER - Employment Rate
GAP – Global Action Plan
GBD - Global Burden of Disease
GDP - Gross Domestic Product
HDI – Human Development Index
IAPB - International Agency for the Prevention of Blindness
LFPR – Labour Force Participation Rate
MEP - Mozambique Eyecare Project
MDG – Millennium Development Goal
MSVI – Moderate/Severe Vision Impairment
NCD - Non-Communicable Disease
NTD – Neglected Tropical Diseases
NPV – Net Present Value
PPP - Purchasing Power Parity
RAAB – Rapid Assessment of Avoidable Blindness
RARE – Rapid Assessment of Refractive Error
QALY - Quality Adjusted Life Year
UNDP - United Nations Development Programme
UNICEF - United Nations Children's Fund
URE – Uncorrected Refractive Error
VI - Visual Impairment
VA - Visual Acuity
VAD - Vitamin A Deficiency
VLEG - The Vision Loss Expert Group
WHO - World Health Organization
WTP – Willingness to Pay
YLD - Years Lost due to Disability
YLL - Years of Life Lost
“The enhanced delivery of eye care services to the world's blind and visually impaired population can only profit from a more concerted multidisciplinary approach which incorporates the fundamental economic and logistic realities that such colossal undertaking entails. Failure to adequately incorporate economic and operations research methods in the delivery of eye care services will only serve to re-enforce the widespread misconception that blindness prevention and treatment is the sole task of ophthalmic professionals.”

Smith, 1995; page 516
Thesis abstract

Purpose
The purpose of this thesis is to investigate potential key determinants of the success, or otherwise, of endeavours to address avoidable Visual Impairment (VI) by addressing Uncorrected Refractive Error (URE) in Mozambique and the wider region of sub-Saharan Africa by providing optometric services. It includes a Cost Benefit Analysis (CBA) of a higher education optometry training programme, barriers that might prevent the realisation of overarching goals despite a successful training programme, and a Willingness to Pay (WTP) analysis to inform the pricing structure and to determine the financial sustainability of the system.

Methods
A standard CBA methodology was applied to ascertain societal net benefit. Costs including those associated with establishing an optometry service. Benefits were calculated by considering how addressing URE could increase productivity. Disability weighting (DW) for VI was applied. The WTP and barriers studies were community-based cross-sectional using two-stage cluster sampling methodology stratified by urban and rural participants. Data were collected by means of face to face interviews using structured questionnaires in Nampula Province, Mozambique. WTP values were ascertained using a stated choice and a bidding game technique, where by the final value is stated after a negotiation. Results were verified using scope analysis and comparisons between WTP values and income levels.

Results
The potential exists, by addressing URE in 24.3 million economically productive persons, to achieve a net present value societal benefit of up to $1.1 billion by 2049, at a Benefit-Cost ratio of 14:1. Perceived cost to the individual needing to access services was the most significant barrier, identified by at least one in every two participants (53%). The second most frequently stated barrier, identified by over a quarter of participants (28%), was the lack of felt need. The average amount in USD participants would be willing to pay for refractive services was US$12 for stated choice and US$15 for the bidding game methodology.

Conclusion
An optometry training programme designed to address the burden of URE in Mozambique, and Lusophone Africa, is economically justifiable in terms of the increased productivity that would result due to its implementation. The cost of refractive services must be addressed if the burden of URE is to be reduced. While the average WTP value lies between US$12 and US$15, for the public optometry system in Mozambique to be viable, policy planers must consider that nearly 70% of respondents were not willing to pay this value. The price of having an eye test and spectacles must not act as a barrier to access.
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Chapter 1. Background and purpose

1.1 Introduction
It is estimated that 285 million people are visually impaired worldwide. 39 million are blind and 246 have low vision. 80% of all VI can be prevented or cured (WHO 2014a). From the existing body of evidence it is clear that urgent action on both a national and global level is needed to prevent and control the rising levels of unnecessary vision loss (Taylor 2007). Uncorrected refractive error (URE) is the main cause of moderate and severe visual impairment (VI) (WHO 2014a). The majority of cases of URE can be addressed through an eye test carried out by a trained professional and a pair of spectacles.

Approximately 90% of the people with VI live in low-income settings. (WHO 2014a). Mozambique is one of the least developed countries in the world, with life expectancy, educational attainment and income levels amongst the lowest on earth (UNDP 2013). In Nampula Province in Northern Mozambique, URE prevalence was 2.6% and was found to be the primary cause of vision impairment among 64.5% of cases. The spectacle coverage for URE was 0% (Loughman et al 2014).

Prior to 2009, there were no optometric services to address URE in Mozambique. Although some of the burden of URE was addressed by other eye health cadres, namely ophthalmologists and ophthalmic technicians, there were no optometrists. The establishment of a College of Optometry in Mozambique presented a unique opportunity to conduct research and generate evidence.

The purpose of this thesis is to investigate potential key determinants of the success, or otherwise, of endeavours to provide optometric services as a means to address avoidable VI by addressing URE in Mozambique and the wider region of sub-Saharan Africa.
This thesis will investigate potential key determinants of the success, or otherwise, of endeavours to address avoidable Visual Impairment (VI) by addressing (URE) in Mozambique. The findings are expected to be relevant to the understanding of the development of optometric services in the wider region of sub-Saharan Africa. The objective of the research is to test how economically justifiable it is to develop a cadre of eye health professionals whose main function is to address URE. It also aims to establish the factors that may prevent the newly trained optometrists from reducing the vision impairment burden to their full potential. The thesis will also explore how people value their sight and refractive error services. As the optometry profession in Mozambique is still in a fledgling state, the research included in this thesis will contribute to understanding the impact of the development of this cadre.

It includes a Cost Benefit Analysis (CBA) of a higher education optometry training programme, barriers that might prevent the realisation of overarching goals despite a successful training programme, and a Willingness to Pay (WTP) analysis to inform the pricing structure and to determine the financial sustainability of the system.

Following an introduction, this chapter introduces the Global Burden of Disease and the current international response, including the Millennium Development Goals, as well as future responses. Gender and health area also discussed. The burden of blindness and VI are discussed. The main causes and consequences of blindness and VI are presented. A summary is provided of how blindness and VI fits into the wider global health agenda. The chapter includes epidemiological and prevalence data. It summarises the current situation and what is being done to reduce the burden. The social and economic impact of addressing blindness and VI is also discussed, as well as an introduction to the global political landscape, which summarises what is being done by various stakeholders to reduce the burden of blindness and VI.
The next chapter focuses on providing detailed information on the country of Mozambique – including details of its history, as well as its approach to both health, and education. The concept of human development is introduced and Mozambique’s progress towards it is discussed. Following on from the global information presented in the previous chapter, prevalence of blindness and VI specifically in Mozambique is discussed. The national education system in Mozambique is detailed, including both primary, secondary and tertiary education.

Chapter four focuses on exploring human resources for health and the Mozambique Eyecare Project. It explores how the optometry course that was developed fits into the national education and public health model. The wider community benefits of optometry and higher education are discussed as well as some of the challenges that the programme had to overcome to successfully train health professionals.

The analytical chapters of this thesis include a CBA of a higher education optometry training programme, barriers that might prevent the realisation of overarching goals despite a successful training programme, and a WTP analysis to inform the pricing structure and to determine the financial sustainability of the system.

The following section introduces each of these analytical chapters in turn. It presents the existing literature and key thinking on each topic, as well as describing how the research questions addressed fit into the knowledge base and contribute to the discussion.

1.2 Cost Benefit Analysis

The first analytical research question was centred on investigating whether funding in optometry as a profession is a worthwhile investment in addressing the lack of refractive services. It has
been recognised for the last twenty years that economic analysis of eye health services are needed to provide evidence for policy making (Smith 1995). Failure to deliver economic research in the delivery of eye health services will reinforce the misconception that addressing blindness and VI is the sole task of eye health professionals. To reduce the burden of blindness and VI, alongside epidemiological and pathological research, evidence on eye health services produced by employing economic and social methodologies is needed (Smith 1995).

There is intense competition for resources both within eye health and also the wider public health field, particularly in the global south. Economic analysis can be used to identify criteria and indicators to allow informed decisions to be made about the distribution of scarce resources (Shamanna et al 1998). As such, it was determined that a health economics study was needed to explore the justification of allocating resources to optometry. Cost Benefit Analysis (CBA), Cost Effectiveness Analysis (CEA), Cost Utility Analysis (CUA) and Cost Minimisation Analysis (CMA) were identified as the methodologies most pertinent to the field of economics and eye health (Brown & Brown 2005).

In order to make a decision on which methodology was suitable, an understanding of all four methodologies had to be gained. The following describes the four main methodologies described in Brown & Brown (2005).

**Cost Benefit Analysis**

CBA compares what is spent on an intervention with what is saved as a result of the intervention. It is particularly useful for demonstrating savings associated with health care policy decisions (Brown & Brown 2005). CBA illustrates the benefits of an intervention in economic terms. The allocation of limited resources for health is often prioritised based on returns to society. This type
of analysis is useful as it allows justification for the spending of resources on a particular intervention, depending on how beneficial this course of action would be (Shamanna et al 1998). CBA are only as strong as the assumptions that they are based on. Inadequate data and simplified assumptions about the costs and benefits may lead to credibility challenges. As a methodology, CBA can be very sensitive to the assumptions which are required to complete the estimation of the benefits and the costs of the intervention (Moore 1995).

CBA is most useful for analysis of a single program or intervention. It assists with determining a programme’s total benefit to society, and whether this exceeds the cost to society. A weakness of CBA is placing monetary values on all (or most) costs and benefits (Cellini & Kee 2010).

**Cost Effectiveness Analysis / Cost Utility Analysis**

CEA measures what is spent in return for a particular benefit. The benefit may be measured in different ways, including years of life gained, years without suffering saved, disability free years and so forth (Brown & Brown 2005). CUA measures what is spent in return for value gained. It is often regarded as being linked or a sub-methodology of CEA. The value is often measured in terms of improvement to length of life, or quality of life, or both. This form of analysis uses a single value, allowing comparison between interventions both within eye health and wider health fields (Brown & Brown 2005).

Many interventions to prevent vision loss have been shown to cost effective, and are often described as among the most cost effective of all known medical interventions (Smith & Smith 1996). Eye health has a proven range of relatively low-risk, high success and highly cost effective interventions (Taylor et al 2007). In particular, cataract surgery is regularly described as

A common form of value for CEA/CUA is the Quality Adjusted Life Year (QALY). QALYs were first used in 1970s to indicate a health outcome measurement unit that combines duration and quality of life (Carlton et al 2008). QALYs are useful for measuring and comparing health effects of varied interventions across diverse diseases and conditions. They represent the effects of a health intervention in terms of the gains or losses in time spent in a series of “quality-weighted” health states (Neumann & Weinstein 2010).

The QALY combines the effects of health interventions on mortality and morbidity into a single index. QALYs are informed by health related quality of life judgements or values. The question as to whose values do (or should) count is a matter for local arbitration within the decision-making framework of specific societies and their individual health-care systems. In the past, many departments responsible for national health, including that of the USA and the United Kingdom, endorsed the QALY for their standardized methodological approach to promote comparability in cost-effectiveness analyses of different health-care interventions (Weinstein et al 2009).

QALYs are therefore a valuation of health benefit. In using them, it is assumed that a major objective of decision makers is to maximize health or health improvement across the population subject to resource constraints. It must also be assumed that health or health improvement can be measured or valued based on amounts of time spent in various health states (Weinstein et al 2009).
Lester (2007) compared the cost-effectiveness of school eye screening in India to a primary eye care model, found school screening a highly cost-effective method of addressing URE in school-age children. The undiscounted cost of the school eye screening per QALY was found to be US $18.11 (Lester 2007). However, as not all children can be examined through school screening, comprehensive eye care clinics are also important for reducing URE, despite coming at a higher cost. The undiscounted cost for the primary eye care model per QALY was US $45.42 (Lester 2007).

Another way of measuring disease burden is the Disability Adjusted Life Year (DALY). The DALY was developed in the original GBD 1990 study to assess the burden of disease consistently across diseases, risk factors and regions. One DALY can be thought of as one lost year of "healthy" life. The sum of these DALYs across the population, or the burden of disease, can be thought of as a measurement of the gap between current health status and an ideal health situation where the entire population lives to the maximum achievable age, free of disease and disability. It is assumed the desired situation is where everyone lives to old age in full health (WHO 2009). For a disease or health condition, DALYs are calculated as the sum of the Years of Life Lost (YLL) due to premature mortality in the population and the Years Lost due to Disability (YLD) for people living with the health condition or its consequences (WHO Metrics 2014). A strength of using the DALY metric is that they can be used to assess and compare the relative impact of a number of diseases locally and globally. As NTDs tend to disable those suffering with them, rather than kill them. The DALY metric takes the chronic effect of these infections into account (Hotez et al 2014).

A weakness of using the DALY metric is that it is only considers direct health loss. It does not take into account the economic impact of disease that results from school attendance, child
development, agriculture or productivity. Direct cost of treatment, surveillance and prevention measures are also excluded from the DALY calculation. The social stigma for many suffering NTDs is also not taken into consideration. NTD control and elimination efforts could produce social and economic benefits not necessarily reflected in the DALY metrics, especially among the most affected poor communities (Hotez et al 2014).

A study into the cost-effectiveness of screening programmes for refractive error in India used DALYs rather than QALYs. It found that at the GDP cost-effectiveness threshold, urban school-based screening was highly cost-effective and rural school-based screening was moderately cost-effective for children aged five to 15 years and highly cost-effective for those aged seven to 15 years (Frick et al 2014).

The study found that the school-based screening averted 2.5 DALYs more than no screening at an incremental cost of $1,420 and the incremental cost per DALY averted was $574. The primary eye care screening averted 3.5 DALYs and cost $4,343 more than no screening. The incremental cost per DALY averted for primary care compared with school-based screening was $2,759. For 1,000 children aged seven to 15 years, the school-based screening averted 8.6 DALYs at an incremental cost of $1,910 and the incremental cost per DALY averted was $221. The primary care screening averted 12.3 DALYs at an additional cost of $5,888. The incremental cost per DALY averted for primary care compared with school-based screening was $1,075. In rural India, for 1,000 children aged seven to 15 years, the additional DALYs were 1.0 and costs were $1,235 and the incremental cost per DALY averted was $1,211 for school-based screening, while the incremental DALYs were 1.5 and costs were $3,760 for primary care screening, over no screening. The incremental cost per DALY averted for primary care compared with school-based screening was $5,775 (Frick et al 2014).
CEA is a useful technique to help determine which of a set of alternative programs or projects achieves the greatest outcome for the costs. It is also helpful where outcomes are either intangible or hard to express using monetary values. A weakness of CEA is that it provides no value for the output, leaving that to the subjective judgment of the policymaker (Cellini & Kee 2010).

Research by Loomes & McKenzie (1989) indicate that for some time there has been concern about using QALYs as a measure, as they fail to take into account some of the critical factors which affect preferences over different health care scenarios. Ultimately, QALYs are based on a political choice. The issue as to whose values shall count is not a scientific one but a political one (Williams 2012). Therefore, the assumptions upon which CUA is based may or may not represent the views of the patient or those who care for them. This calls into question the use of CUA and QALYs to inform patient decision making (Kind et al 2009). There is also the issue of using QALYs for medical policy decision making.

In the USA, the Patient-Centered Outcomes Research Institute (PCORI) is authorised by Congress to fund and disseminate research that will provide information about the best available evidence to help patients and their healthcare providers make more informed decisions. PCORI’s research is intended to give patients a better understanding of the prevention, treatment, and care options available, and the science that supports those options (PCORI 2014). A key function of PCORI is to undertake comparative-effectiveness research. However, the Patient Protection and Affordable Care Act (ACA) prohibited this institute from developing or using cost-per-QALY thresholds.

“The Patient-Centered Outcomes Research Institute . . . shall not develop or employ a dollars per quality adjusted life year (or similar measure that discounts the value of a life because of an
individual’s disability) as a threshold to establish what type of health care is cost effective or recommended. The Secretary shall not utilize such an adjusted life year (or such a similar measure) as a threshold to determine coverage, reimbursement, or incentive programs under title XVIII.” (PP & ACA 2010).

This ban was controversial. Advocates of the QALY argue that the use of explicit, standard metrics such as cost-per- QALY ratios has the advantage of transparency and can help direct our resources toward the greatest health gains (Neumann & Weinstein 2010).

Decision makers in other countries have also questioned using the QALY to inform policy. The United Kingdom has proposed that the National Institute for Health and Clinical Excellence (NICE), will not use cost-per-QALY ratios in the future to make recommendations. In Germany, the Institute for Quality and Efficiency in Health Care rejected the cost-per-QALY model on ethical and methodological grounds. Many countries (including France, Spain, and Italy) have opted for approaches other than those that use QALYs (Neumann 2011).

The question of whether it is feasible to estimate a monetary value of a QALY is still up for debate (Donaldson et al 2011). QALYs are not the only way of valuing health benefit. Other methods of valuing health care are not banned.

Cost Minimisation Analysis

CMA compares interventions that have the same objective and are of equal effectiveness, with the objective of establishing which costs less (Brown & Brown 2005). CMA was rarely found to analyse the impact of eye health. One study compared the cost of using recycled spectacles to address URE, as opposed to using new ready-made spectacles (Wilson et al 2012). The authors conclude that using ready-made spectacles costs less than using recycled spectacles. As well as
not being a sensible option in terms of cost, the use of recycled spectacles has negative developmental, social and economic implications, negating their suitable intervention for addressing URE (Wilson et al 2012, Ramke et al 2006).

A common problem with using this methodology effectively is finding two or more interventions with exactly the same outcome, resulting in this methodology rarely being used for eye health economics. Two interventions are not often directly comparable, which limits the usefulness of CMA (Brown & Brown 2005).

While each methodology has its strengths and weaknesses, a CBA methodology was selected, particularly for its ability to demonstrate savings associated with health policy decisions. CMA was dismissed, as its primary function of compares interventions was not appropriate to the context of addressing URE in Mozambique. The debate around the usefulness of determining the value of QALYs and other measures of disease burden, and how to use them to inform in decision making continues (Kind et al 2009, Donaldson et al 2011). The aim of the research was to quantify the economic impact of the optometry programme in Mozambique. CBA has been described as being most useful in the analysis of a single program or policy to determine whether the program’s total benefits to society exceed the costs (Cellini & Kee 2010). After considering the objective of the study, as well as assessing the data available, and in light of the continuing debate around how to usefully and reliably conduct CEA/CUA, it was decided that a CBA should be undertaken. If further time and resources were available, and if the objective of analysing the effectiveness of optometry as an intervention was adopted, a CEA/CUA could be carried out to complement the research presented in this thesis.
1.3 Developing the CBA methodology

The body of evidence and existing literature suggests that the CBA should consider the societal perspective to be consistent with economic theories of public welfare. Analyses conducted from the societal perspective include a comprehensive list of costs and effects associated with a condition or its treatment. Costs must be broken down and presented as separate line items, to facilitate comparisons among studies (Frick et al 2010).

There are several examples in the literature of applying CBA methodology to blindness and VI. A study based in the Gambia found that the costs associated with an eye health programme could easily be justified, when the societal benefits were considered. A Rate of Return of 10% could be achieved by the end of the period analysed. Although the project did not break even until 18 years after its inception, the sight restoring interventions that allowed individuals to be more productive across time resulted in a positive net benefit being achieved. The program costs were calculated by how much was invested by the partners involved. Societal costs in terms of lost productivity (which are inversed to form the benefits) were calculated by applying DWs to GDP per capita data. The Labour Force Participation Rate (LFPR) and Employment Rate (ER) were also taken into account. For each blind person it was assumed that a fully sighted person would need to assist them with certain tasks, causing an additional productivity loss. The results indicate that program costs were greater than the economic benefits during the implementation period, but the lifetime benefits suggest a substantial gain (Frick et al 2005).

A CBA of blindness in India included direct costs incurred by the individual due to lost productivity (using GPD per capita) and the indirect cost of the family having to look after the individual, assumed to be 10% of the time of one economically active family member. It was assumed that only 20% of blind persons would enter economic activity if they were able to do so.
It was assumed that the remaining 80% would not be economically productive. The study estimated that the economic burden of blindness in India in 1997 was $4.4 billion, and the cumulative loss over a lifetime is $77.4 billion. The cost of treating all cataract blindness in India was estimated to cost $0.15 billion. Even if 52% of the country’s blindness due to cataract is treated costing $0.15 billion, and a conservative blindness reduction rate after surgery of 80% is assumed, and 45% of the people blind with cataract are in the age group that contributes to the economy, the saving would be a considerable $1.1 billion. Importantly, the study indicated that until a child with blindness is 15 years old, only the family bears the economic burden. After this, society bears the burden as a person unable to work does not contribute to the economy (Shamanna et al. 1998).

Research from China indicated the high economic returns associated with ensuring children who need them receive spectacles. A randomised controlled trial shows how providing spectacles and addressing VI can improve educational outcomes. Higher levels of education increases economic growth, leading to rising incomes and improved quality of life. The study is approached from an education perspective, rather than an economics perspective. Despite the authors making clear that the CBA methodology they employed was ‘simple’, the finding that very high economic returns are associated with children wearing spectacles is of relevance (Glewwe et al 2012).

A study focused on the costs and benefits of addressing avoidable and preventable blindness in Australia found that the rate of return was 4.8 for every Australian dollar spent in blindness prevention or treatment. The authors noted that a high rate of return does not guarantee implementation. Decisions on funds and resource allocation are influenced by a broader range of factors than rates of return. Societal perception, politics and ease of implementation will all impact decisions on distribution (Taylor et al 2006).
In a study focused on global economics productivity, the potential benefit of the VISION 2020 initiative was found to equal an economic gain of $102 billion. The DWs of 0.600 for blindness and 0.245 for low vision were used to calculate the impact of the burden on productivity. The authors assumed that blind individuals would require assistance from sighted adults, estimating the time required would account for 10% of the sighted persons working time. It was also assumed that those over 65 years of age were half as productive as those between 15 and 64 years old. Although this study does not rigidly follow CBA methodology, as the costs of implementing the VISION 2020 initiative were not considered, it does provide an insight into the substantial benefits that could potentially be achieved if blindness and VI are reduced by the initiative (Frick & Foster 2005).

Age-related macular degeneration is the primary cause of blindness in industrialised countries, with the main risk factor being ageing. Although not listed as a VISION 2020 priority condition, it currently causes significant blindness and VI and it is likely to be responsible for a significant burden in the future as life expectancy increases. When considering the cost and benefits of reducing its impact, it was found that if the progress of the disease could be slowed by just 10%, this would save an average of Australian $250 million each year for the next 20 years (Taylor et al 2006).

A study developed to determine costs and benefits of VA screening or photoscreening in children derived cost estimates and referral rates for surgical treatment from a managed care database and the United States Social Security Administration. The results found that all benefit cost ratios (BCRs) exceeded 1.0, indicating that all screening programs studied had benefits that exceeded the cost of screening. The total net benefit was highest for photoscreening in children of 3 to 4 years of age ($19,412) and the least for VA screening in children 7 to 8 years of age ($15,179).
The BCR was highest for the VA screening in children 3 to 4 years of age ($162) and least for photoscreening in infants 6 to 18 month old ($140) (Joish et al 2003).

The number of CBA studies focusing exclusively on URE are limited, but those that do exist present some interesting findings. A CBA designed to examine the potential connection between the astigmatic refractive corrections of subjects using computers and their productivity and comfort reported a CBR of at least 2.3 for the visual correction of an employee (total cost 268 dollars). This was based on a conservative estimate of an overall 2.5% increase in productivity with appropriate astigmatic refractive correction for an employee earning 25,000 dollars per year (Daum et al 2004).

A study based on global level conservatively estimated that the potential productivity loss associated with the burden of URE was $121.4 billion in international dollars (Smith et al 2009). Using prevalence rates and economic data from different regions of the world, the authors calculated the burden or cost of URE by using GDP per capita as a proxy measure for productivity. They adjusted the data for both LFPR and ER. To keep the estimates conservative, they assumed that individuals older than 50 years old did not contribute to the economy. By excluding individuals older than 50 years old, the burden of presbyopia was largely excluded. Had presbyopia been included, the proportion of lost productivity may have increased. Without including presbyopia, it was estimated that the direct global cost of addressing URE was $26 billion (Smith et al 2009). The authors acknowledge that this direct cost does not take into account that in most of the developing world, infrastructure and human resources are lacking, thus the true cost of addressing URE could be significantly higher. However, even with the most conservative assumptions, it is clear that correcting URE on a global scale would result in
considerable savings per case treated and a net benefit to the global economy in terms of increased productivity (Smith et al 2009).

1.4 Barriers

The second analytical section of this thesis seeks to establish if there are any barriers to the utilisation of refractive services in Mozambique. The quality of an eye health service and the quantity of eye health workers will be irrelevant if fundamental barriers exist limiting service uptake. Understanding these barriers will be essential if the benefit of the optometry programme in Mozambique is to be maximised.

People who are blind or have VI may encounter barriers limiting their access to the eye health services, education and rehabilitation they require due to reduced vision (Faal & Gilbert 2007). As already stated, the relationship between blindness and poverty is complex. Poverty may also act as a barrier to access. A major barrier to the uptake of cataract surgery has been shown to be the inability to afford surgery (Kuper et al 2008). This may result in the patient waiting until their vision is severely limited before seeking medical help. A study in Ethiopia indicated that indirect costs, including transport, food and lodgings, were the main barriers to uptake of cataract and trichiasis services (Melese et al 2004). Knowledge of interventions and lack of understanding of how interventions can restore sight can also influence uptake of services (Lewallen & Courtright 2001). Culture, religion, gender, language and conflict may also limit service uptake.

Geography and distribution of resources may also limit service uptake. Rural poverty may reduce the ability of those living outside of major settlements from getting the eye health services that they need (Ho & Schwab 2001). This is particularly pertinent to access to refractive error
services and spectacles (Dandona & Dandona 2001a). Distance from or restricted access to the
eye health service provider may result in those who need care waiting to accrue severe visual
loss before accessing the services they require. By the time the patient seeks assistance they may
have lost employment opportunities and suffered reduced economic production for a period of
time. To eliminate avoidable blindness, region specific resources and services are needed to deal
with visual problems at an earlier stage, before the patient suffers loss of economic productivity
(West & Sommer 2001).

Even when geographic and economic barriers to a service are removed, this does not guarantee
their use (Sommer 1995). A study in Baltimore, USA, found that even when a refraction service
was provided at no cost, not all patients accessed the services or were using spectacles they were
prescribed (Preslan & Novak 1998). In Australia it was found that, despite the existence of
universal Medicare insurance and clinics in public hospitals offering certain services without
charge, not everyone availed of the services they needed (Keeffe et al 2002). A study in India
found that, of the subjects analysed who did not seek eye health services despite noticing a
change in vision, 49.5% cited personal reasons, 30.8% cited economic reasons and 19.6% cited
social reasons. The services may well have been provided free of charge if the patient had
presented themselves to a clinic, suggesting lack of information was as much of a barrier as lack
of funds to pay for the service (Dandona et al 2000).

1.5 Willingness to Pay

The first optometrists graduated from Universidade Lúrio in 2013. Although some of the
graduates have remained at the university as educators or enrolled in postgraduate programmes,
the vast majority of them will be absorbed into the public health system. In order to gain the
maximum societal benefit of the new cadre of optometry, a greater understanding is needed of how the public views and values refractive services.

WTP describes the maximum amount a patient is willing to pay to receive a given outcome. The logic behind this approach is that the subject will assess all possible advantages and disadvantages, both monetary and non-monetary, and make a decision quantified in a monetary value to represent the perceived worth of a given outcome (Maxwell et al 2008). WTP analyses can provide vital information that can be used to inform eye health planning. Failure to conduct this type of analysis can result in prices of eye health services being set at inappropriate levels or entrench cost as a barrier to access.

A person’s WTP will be influenced by the environment within which they live. This includes variations between regions, countries and even urban/rural differences. In Timor-Leste it was found that the urban population were willing to pay $3 for spectacles, but the rural population was more likely to be unwilling to pay $1 for the same correction (Ramke et al 2007). Research in Zanzibar, East Africa found that the WTP for spectacles was $3.14 (Laviers et al 2011). In Cambodia 76.6% of the population sample (193 people) were willing to pay at least $0.38 for spectacles (Ramke et al 2008).

WTP covers a diverse range of methodologies, all of which attempt to establish what a person is willing to pay for a particular service or outcome. For the findings of a WTP study to contribute to policy making in Mozambique, it is essential to be aware of some of the criticisms and limitations of it as a methodology. WTP responses can be under sensitive to the magnitude of benefit. Research into WTP for health care found that a disproportionately high number of people state they would pay approximately £50 (the equivalent of $80) for any reduction in risk of death or injury (Cookson 2003). The WTP value of interventions that yield relatively small
benefits may be inflated beyond reasonable value. Also, WTP methodology tends to inflate valuations for interventions that are asked about compared to interventions not asked about. WTP acts as a magnifying glass for the intervention in question. When questioned on an intervention in isolation, people appear more willing to pay for it than when asked about the same intervention in relation to other interventions (Cookson 2003). In addition, stated WTP value may not reflect the individual’s ability to pay for an intervention. The actual mobilisation of money to pay for an intervention when needed may require that the individual, family or society sacrifice other necessary goods including food, fuel or even education (Saulo et al 2008). Such sacrifices may not influence a stated WTP value as it is hypothetical, but may have an impact on the ability to pay. In cases like this it is hard to simulate the conditions under which a decision may need to be made.

Any service needs to take into account the realities in which it operates. Taking the aforementioned concerns into account, a robust WTP methodology is required to provide reliable data on the situation in Mozambique. While the provision of eye health services should not be determined by ability to pay, it is clear that costs must be covered if the system is to be sustainable (Holden et al 2000). Even small profit margins can result in systems becoming sustainable, if resources are reinvested in the system (Laviers et al 2011). Evidence from research in Cambodia indicated that a slight increase in price of an eye health service may not impact on the patients’ WTP (Ramke et al 2008). An acceptable increase in pricing would generate more revenue without reducing service uptake. The extra profit could then be used to support subsidisation for those who could not afford the cost of the service. However, price elevations are likely have a detrimental effect on the equity of utilisation. Strategies may be required to accommodate the paying capacity of those who cannot afford the new price (Ramke
et al 2008). With the profession of optometry still developing in Mozambique, the results of a WTP will be vital to inform health policy and planning.

1.6 Conclusion

This introductory chapter has made it clear that the burden of blindness and VI remains significant despite most causes being curable or preventable. It is also clear that the global south bears the majority of this burden. URE remains the major cause of VI, despite being easily addressed with an eye test and appropriate spectacles. Mozambique is a country where the burden of URE remains a serious issue. The development of a College of Optometry in Mozambique aimed to improve the capacity human resources for health to address URE and other eye problems. Its establishment provided a unique opportunity to analyse the success, or otherwise, of endeavours to address avoidable VI by addressing URE in Mozambique by providing optometric services.

The analytical chapters of this thesis contribute to knowledge in several ways. Through the delivery of a Cost Benefit Analysis (CBA) of a higher education optometry training programme, this thesis will offer explore the potential of such a programme in terms of its economic justifiability. The analysis of barriers contributes to the discussion focused on factors that might prevent the realisation of overarching blindness and VI reduction goals, despite the delivery of a successful training programme. Finally the WTP study offers an insight into to inform the pricing structure and to determine how people value their eyesight and what they would be willing to sacrifice for an eye test and spectacles. This in turn informs the financial sustainability and viability of a system designed to reduce unnecessary VI due to URE.
Chapter 2. Global Issues affecting Blindness and Visual Impairment

2.1 Introduction

This chapter is focused on examining global issues that affect blindness and VI. It starts by discussing the global political health landscape, including the public health situation, the Millennium Development Goals (MDGs), and the global burden of disease (GBD). The MDGs have dominated both the health and development agenda for over a decade. These are time-bound and quantified targets for addressing extreme poverty. They cover many dimensions including income poverty, hunger, disease, lack of adequate shelter, and exclusion-while promoting gender equality, education, and environmental sustainability. They aim make a reality of the delivery of basic human rights, including access to health, education, shelter, and security.

It goes on to analyses issues of public health and gender, which have not received adequate attention in the past. Gender is found to be a highly relevant issue when discussing blindness and VI, as a disproportionately high number of women and girls suffer the burden, with two-thirds of the world’s blind being women.

As the era of MDGs comes to an end, an analysis is provided that looks forward to what comes next for development. The strengths and challenges that a new approach may bring are explored. Universal health coverage emerges as a central theme to the Post-2015 agenda, which must include eye health if it is to be comprehensive.

The chapter then moves on to analyse the main causes of blindness and VI. As the global population continues to grow and the longevity of people’s lives increases, the challenges presented by blindness and VI will be exacerbated. Eye health conditions such as refractive error
and cataract, whose prevalence is linked to aging, are likely to increase in prevalence. Without further interventions, the global magnitude of avoidable blindness and VI will continue to escalate. Clinical definitions of blindness and VI are presented, followed by a presentation of the current epidemiological data and some background information on all the main causes of blindness and VI.

Many of the common causes of blindness and VI, can be easily addressed, which begs the question why the burden still exists to the extent that it currently does. An overview of existing studies that analyse the social and economic impact of addressing blindness and VI are presented. There is a consensus that eye health interventions are often effective and economically justifiable. Blindness and VI can restrict education and economic productivity. It can also impact on social wellbeing.

The social and economic impact of URE, the world’s leading cause of VI, is described in detail. Addressing URE is found to be a priority because of the burden of blindness and VI that it is responsible for and because of how easily and affordably it can be treated. URE has been shown to have negative consequences on individuals and societies. Developing human resources to deal with it is presented as a sustainable solution.

The existing data on blindness and VI in Mozambique is discussed and analysed. This provides clarity on the scale of the problem that needs to be addressed. Mozambique does not exist in a vacuum and as such, an analysis is also presented of the global political landscape focused on blindness and VI. This chapter builds on the information presented in the introductory chapter, providing a solid understanding of the geographic context, the health context and the development context relevant to the research question addressed in this thesis.
2.2 Millennium Development Goals

In 2000, world leaders signed The United Nations Millennium Declaration, committing them to combating poverty, hunger, disease, illiteracy, environmental degradation, and discrimination against women. The United Nations MDGs are a set of 8 goals derived from this declaration that UN Member States have agreed to try to achieve by the year 2015.

The 8 goals aim to eradicate extreme poverty and hunger, achieve universal primary education, promote gender equality and empower women, reduce child mortality, improve maternal health, combat HIV/AIDS, malaria and other diseases, ensure environmental sustainability, and lastly to develop a global partnership for development. Each MDG has targets set for 2015 and indicators to monitor progress from 1990 levels. Several of these relate directly to health (WHO 2014c).

Although not all the MDGs are relevant to this thesis, as the broad theme is development, it is important to provide all the goals for context. According to the WHO, all of the MDGs apart from achieving universal primary education and promoting gender equality and empowering women are directly relevant to health (WHO 2014c).

However, it could be argued that health, and in particular eye health, can also contribute to the goals of achieving universal primary education and promote gender equality and empower women. Evidence suggests that 90% of children with VI in low-income countries do not go to school. Also, there are more boys than girls in schools for the blind (Faal & Gilbert 2007). The lack of adequate infrastructure, suitable educational materials, or qualified teachers, may prevent visually impaired children from gaining an education. The distance between home and school and lack of awareness on the part of parents may also present barriers, reducing school
attendance and academic performance. Blind adults may depend on children to help them at home. This may keep the children away from school (Faal & Gilbert 2007).

In a Position Paper published in 2012, IAPB cited the lack of attention paid to people with disabilities within the current MDGs has meant they have by and large failed to benefit from the investments in health delivered as a result of the MDGs (Ackland 2012). The health rights of people with disabilities will have to be realised if progress is to be made towards eliminating avoidable blindness, achieving the MDGs, and whatever follows them. Further discussion on blindness and VI and the MDGs in the section on the global political landscape.

2.3 Global Burden of Disease

For health systems to be successful and effective in improving population health, the key challenges they currently face, and may face in the future, must be understood. Before the early 1990s, data on GBD, injuries, and risk factors was limited, inconsistent and incomplete. To address this evidence gap, the World Bank and the WHO launched the first GBD Study in 1990. The GBD approach offers methodological consistency in critically appraising available information on each condition. The purpose was to make the data and information comparable and systematic. Results for countries with incomplete data can be estimated. The burden of disease can be assessed with the use of standardised metrics. Comprehensive assessments of the state of health in the world have been made in the various revisions of the GBD Study for 1990, 1999–2002, and 2004 (Murray & Lopez 2013).
The GBD studies uses the DALY as a metric, which requires DWs that quantify health losses for all non-fatal consequences of disease and injury. There has been extensive debate about a range of conceptual and methodological issues concerning the definition and measurement of these weights (Salomon et al 2012). The debate around DWs is discussed in more detail in a subsequent chapter of this thesis.

A study using data extrapolated from the 2004 GBD study that focused specifically on blindness and VI indicated that the highest number of DALYs for eye disease were found in East Asia and the Pacific (including China) and South Asia (including India), followed by sub-Saharan Africa and the high-income economies. The burden of refractive errors predominantly affects East Asia and the Pacific, South Asia, and high-income economies, as shown in Figure 1. Contributors to the burden of eye disease at the global level were refractive errors (27.7 million DALYs), cataract (17.7 million DALYs), macular degeneration (9.3 million DALYs), glaucoma (4.7 million DALYs), trachoma (1.3 million DALYs), and vitamin A deficiency (VAD) (0.6 million DALYs). The highest number of DALYs per 100000 people was observed in the middle- and low-income countries of East Asia and the Pacific, South Asia, and sub-Saharan Africa (Ono et al 2010).

Ono et al (2010) note that the GBD study in 2004 used the presenting visual acuity (VA) to estimate the global burden of refractive errors. This was probably underestimated because it was based on epidemiological data from the presenting distance VA. If the presenting near VA was taken into consideration, the imbalance of refractive errors as well as its burden may be greater for females, as females may lack the control of the family finances to procure spectacles for presbyopia. Even high income countries were found to need to strengthen their refractive services (Ono et al 2010). Studies completed in the USA and Australia indicate that even when
refractive services are offered at no cost to the patient at the point of delivery, not everyone who needed spectacles used the service (Preslan & Novak 1998, Keeffe et al 2002).

However, with 90% of people living with blindness and VI living in developing countries, if the goals of VISION 2020 are to be achieved, this is where the efforts need to be focused (WHO 2014a). All the aspects of a self-sustaining system must be developed if the burden of URE in the global south is to be reduced. This includes human resources for eye health and spectacles, to correct vision (Holden et al 2000). Countries from the global north could transfer knowledge, cost-effective techniques, and experience to the developing countries to assist them reduce their URE burden (Ono et al 2010).

The GBD study from 2010 brought together a large community of experts and leaders in epidemiology, economics, statistics, and other disciplines to measure levels and trends in all major diseases, injuries, and risk factors. The report produced new and comprehensive sets of estimates. In total, the study generated nearly 1 billion estimates of health outcomes (IHME 2014).

The GBD 2010 study found that blindness and VI remains a significant cause of disability globally, with 80% of the cases of vision loss being preventable or treatable. The results also indicated that the prevalence of vision loss increases with age. Despite the fact that there is an increasing number of older people in almost every country in the world, recent efforts against blindness and vision loss have reduced the prevalence of blindness and VI dramatically. Also, as populations have increased in size, the absolute number of people with blindness has remained stable and the number of people with VI has increased. The importance of obtaining reliable data on people affected by blindness and VI is important for a range of reasons, including budgeting,
planning, measuring economic impact, measuring the burden of disease, and to strengthen advocacy efforts (Taylor 2010).

**Figure 1 – DALYs due to eye disease, by World Bank region and specific cause: GBD study 2004 (Ono et al 2010).**

The GBD 2013 assessed global progress since the Millennium Declaration was signed in 2000, by providing consistent and comprehensive estimates of diseases. The GBD 2013 report estimates that the number of people living with HIV are 18.7% smaller than UNAIDS’s estimates in 2012. However, the number of people living with malaria is larger than estimated by WHO. Since 2000, the number of people living with HIV, tuberculosis, or malaria have all decreased. At the global level, upward trends for malaria and HIV deaths have been reversed, and declines in tuberculosis deaths have accelerated, indicating progress has been made.
However, 101 countries (74 of which are developing) still have increasing HIV incidence. Since the Millennium Declaration was signed in 2000, progress has been made (Murray et al 2014).

2.4 The Post-2015 Agenda
As the year 2015 rapidly approaches, signalling the end of the MDG era, discussions on the goals, topics, priorities and monitoring and evaluation that will come in the Post-2015 era are gaining momentum (D’Ambruoso 2013). The positioning of health is an urgent challenge as discussions of the Post-2015 agenda rapidly advance. It will be important for health stakeholders (other than the WHO and states), including NGOs, and the private sector should be involved in the planning and implementation of the Post-2015 agenda (Kickbusch & Brindley 2013).

In July 2012, the United Nations Secretary-General Ban Ki-moon announced a 27 member High-level Panel to advise on the global development framework beyond 2015, the target date for the MDGs. The panel included leaders from civil society, private sector and government. The formation of the panel is part of a process designed to deliver open, inclusive consultations involving a range of players including civil society, the private sector, academia and research institutions from all regions, in addition to the UN system, to advance the development framework beyond 2015 (HLP 2014).

The work of the panel reflected new development challenges while also drawing on experience gained in implementing the MDGs, both in terms of results achieved and areas for improvement. The panel delivered a report in 2013, which sets out a universal agenda to eradicate extreme poverty by 2030, and deliver on the promise of sustainable development. The report calls upon
the world to rally around a new Global Partnership that offers hope and a role to every person in
the world (UN 2013).

The authors argue that the Post-2015 agenda is a universal agenda that needs to be driven by five
transformative shifts:

1. Leave no one behind.
2. Put sustainable development at the core.
3. Transform economies for jobs and inclusive growth.
4. Build peace and effective, open and accountable institutions for all.
5. Forge a new global partnership.

The Panel argues that the shape of the Post-2015 development agenda cannot be communicated
effectively without offering an example of how goals might be framed. The following illustrative
goals are presented for health:

- End preventable infant and under-5 deaths.
- Increase by x% the proportion of children, adolescents, at-risk adults and older people
  that are fully vaccinated.
- Decrease the maternal mortality ratio to no more than x per 100,000.
- Ensure universal sexual and reproductive health and rights.
- Reduce the burden of disease from HIV/AIDS, tuberculosis, malaria, NTDs and priority
  NCDs.

Poor health prevents people reaching their potential. Healthy children can gain a better education
and go on to be healthy adults, working longer and more regularly, earning higher and more
regular wages. The evidence analysed by the panel suggests that the benefits of investing in health are immediate and obvious, both for specific interventions and for strengthening health systems more broadly. The panel acknowledge that to achieve the required outcomes, universal access to healthcare is needed. However, they stop short of including universal health care as a goal, instead requesting a basic commitment to ensure equity in all the interconnected areas that contribute to health (UN 2013).

The lack of a specific universal health goal has drawn criticism from some quarters. It has been argued that the proposed targets, which are expressed along specific health challenges, interventions, and diseases, may lead to different players following different agendas. This may result in division and strained relationships, rather than unity and collaboration. It is suggested that universal health coverage anchored in the right to health would allow united advocacy. An alternative proposition to that offered by the panel, is the realisation of the right to health for everyone as a singular health goal. This would be achieved by aiming for the two targets of comprehensive universal health coverage anchored in the right to health and a healthy social and natural environment for all (Ooms et al 2013). Indeed, uniting all parties involved in delivering health around one health goal focused on universal care with multiple sub-goals would recognise that “one size” does not fit all, but that there are a set of system-level constraints to scaling up access to health (Vega 2013).

To achieve universal health coverage people must have access to good health services without fear of financial hardship. It cannot be attained unless both health services and financial risk protection systems are accessible, affordable and acceptable. However universal access is not sufficient. Coverage builds on access by ensuring actual receipt of services. Universal health
coverage and universal access to health services complement each other. Without universal access, universal health coverage becomes an unreachable goal (Evans et al 2013).

The World We Want 2015 is a platform that enables people to engage, visualise and analyse people’s voices on sustainable development. Between September 2012 and March 2013 a Global Thematic Consultation on Health in the Post-2015 Development Agenda was undertaken. It received inputs from a range of people, institutions and organisations from around the world on how best to ensure the health of future generations. The report that emanated from the findings of the consultation found that a rigorous framework is needed for the Post-2015 health agenda, to articulate how sustainable development differs from (and is preferable to) existing development models. As health and development are inextricably linked, greater synergy must be realised between health and other sectors by framing Post-2015 goals so that their attainment requires policy coherence and shared solutions across multiple sectors. The Post-2015 health agenda should do the following:

- Include specific health-related targets as part of other development sector goals.
- Take a holistic, life-course approach to people’s health with an emphasis on health promotion and disease prevention.
- Accelerate progress where MDG targets have not been achieved and set more ambitious targets for the period to come.
- Address the growing burden of NCDs, mental illness, and other emerging health challenges (WWW 2014).

The guiding principles for the new development agenda should include human rights, equity, accountability, and sustainability. The most disadvantaged, marginalised, stigmatised, and hard-
to-reach populations in all countries should be prioritised (WWW 2014). Gender should also be seriously considered.

2.5 Gender and health

Sex refers to biological differences between male and female, such as chromosomes, hormonal profiles, internal and external sex organs. Gender describes the characteristics, roles and norms that a society or culture delineates as masculine or feminine. Gender equity and gender equality are terms that are sometimes used differently in different countries and in different contexts. The WHO Madrid Statement on gender mainstreaming in health policy has a geographical focus of Europe, but the definitions that follow are relevant for all geographical contexts:

**Gender equity**

Gender equity means fairness and justice in the distribution of benefits, power, resources and responsibilities between women and men. The concept recognizes that women and men have different needs, power and access to resources, and that these differences should be identified and addressed in a manner that rectifies the imbalance between the sexes.

**Gender equality**

Gender equality means the absence of discrimination on the basis of a person’s sex in opportunities, allocation of resources or benefits, and access to services (WHO ROE 2002).

Health inequalities between women and men will reflect both biological factors, which are fixed, and gender differences, which are socially constructed and which are open to change. Thus, in terms of health policy the goal is often described as one of gender equity not gender equality.
For example, policies that aim for equal levels of mortality or morbidity among men and women may fail, as some of the differences that exist reflect biological influences on health. It is very difficult to ascertain an exact percentage of the health gap between women and men can be attributed to biology and what to gender. Gender equity in relation to health is not intended to produce equal outcomes for men and women, but instead must address inequalities between women and men in terms of their resources and their opportunities for health, including differences in how well health systems meet their specific needs (Payne 2009).

Gender values may systematically empower one group to the detriment of the other. Analysis of female mortality in countries like India and China is illustrative of this. As per Census 2011 figures, the total female sex ratio in India is 940 per 1000 males and the female child sex ratio is 944 per 1000 boy children. This implies that the excess female mortality is not just confined to newborns and infants but is also prevalent at older ages (Jayaraman et al 2012).

Gender differentials may be caused by a woman not being able to receive required health care because norms in her community prevent her from travelling alone to a clinic (Courtright 2002). A married woman might be vulnerable to infectious disease because societal standards encourage her husband’s promiscuity while simultaneously preventing her from insisting on condom use. A woman might not be able to get timely treatment for illness if the household doesn’t consider it important enough to treat the female member of the family. In each of these cases gender norms and values, and resulting behaviour, negatively affect health. Gender differences sometimes are the single most important obstacle standing between the long term goal of wellbeing of men and women (Jayaraman et al 2012).

Health systems can make important contributions to gender equality and gender equity by addressing gender in a variety of ways. Identifying gender inequalities and addressing gender
equity are also central to good stewardship of health systems. Gender equality and gender equity can be addressed through legislation, organisational processes and information gathering.

Regulatory approaches at national level might address patients’ rights or create a duty for public-sector organizations to address gender equality. This would require commitment from the authorities to work towards gender equality. Informational approaches focus on the role of data in providing evidence and knowledge about gender inequities. Gender-sensitive health indicators may assist identify key differences between women and men in relation to health and in the social determinants of health, in order to support policy change (Payne 2009).

‘Gender budgeting’ is an example of an organisational approach. It refers to gender-based assessment of budgets and a restructuring of revenues and expenditures to increase gender equity. Advantages of this approach include improved economic growth as a result of improvements in women’s education or employment, better understanding of the gender impact of different fiscal measures and ease of implementation (as it is a pragmatic approach that can be seen as a relatively easy starting point). Barriers include the need for political commitment and good stewardship and the need for internal expertise (which may be lacking) and good-quality data of sufficient complexity to allow gender assessments to be made (Payne 2009).

All approaches to overcoming gender issues need to be evaluated in terms of their possible benefits, costs and the barriers that might make introducing change difficult. Some barriers might be overcome by spending more money – adding to costs. Benefits, for example, include increasing the visibility of gender issues, improvements in population health and in efficiency and value for money in terms of services. Costs can include the increased resources needed for training, monitoring, evaluation and the collection of any new data that might be required. Barriers may include a lack of understanding of the issues and a lack of political will. Factors
that might facilitate change could include gender ‘champions’ and prior experience (at local or national level) of gender equity reforms in other policy arenas (Payne 2009).

All health programmes should consider gender sensitiveness, which should include thinking critically about the needs of the specific gender group. Specific health issues according to the needs of the specific gender should be considered. Gender sensitivity does not mean that programmes should have to give special schemes for men or women, rather they should identify which gender group is more vulnerable than the other in relation to what the programme is trying to address. To achieve this, the situation of women be more accurately reflected in routinely collected health statistics, with all statistics collected being disaggregated by sex (Piang et al 2010).

2.6 Diseases and conditions leading to blindness and VI

Although this thesis mainly focuses on URE, it is important to provide some background information on all the main causes of blindness and VI. The following section provides definitions and technological details on the major causes of blindness and VI.

Cataract

Cataract is the clouding of the lens of the eye, which initially prevents clear vision and eventually progresses to blindness if left untreated. Nearly 18 million people are bilaterally blind from cataract in the world, representing almost half of all global cases of blindness. Cataract remains the leading cause of blindness and an important cause of VI across the globe. The main non-modifiable risk factor for cataract is aging. Other frequently associated risk factors are trauma, uveitis, diabetes, ultraviolet light exposure, and smoking. Children are occasionally born
with cataracts, mainly due to genetic disorders. Women are at greater risk than men for developing cataracts and are less likely to have access to services (IAPB 2014a).

The number of people with cataract grows as the world population ages. Immediate visual rehabilitation is possible following cataract surgery, during which the cataract is removed and an intraocular lens (IOL) is inserted. Cataract is easily treated and cataract surgery is considered one of the most cost-effective interventions (Baltussen et al. 2004). However in many remote and poor areas of the developing world, people remain blind from cataract, mainly due to a lack of access to eye care. People living in poverty, particularly those living in a rural location outside of major settlements, may struggle to access the cataract services that are needed (Ho & Schwab 2001). The proportion of blindness due to cataract among all eye diseases ranges from 5% in developed countries to 50% or more in poor and/or remote regions (IAPB 2014a).
One ophthalmologist can undertake approximately 2,000 cataract surgeries a year, provided that there are adequate support staff, infrastructure, and patients who are able and willing to access the facilities (IAPB 2014 a).

In developing countries, poor surgical outcomes and inadequate access to surgery are barriers to reducing the burden of blindness from cataract. Training additional surgeons and providing equipment could help to address both issues. Success also requires improved monitoring of surgical quality. VA after cataract surgery has traditionally been measured weeks to months after the operation, since wound healing can change refractive power, and gradual resolution of common complications such as corneal oedema can substantially improve vision. On occasions, visual decline from surgical complications can also occur (Congdon et al 2013).

In many developing countries, post cataract operation follow-up rates are as low as 20–30% (Limburg et al 2005). Poor follow-up after cataract surgery in developing countries makes assessment of operative quality uncertain. Early vision assessment for all patients and follow-up assessment only for patients who return to the clinic without prompting are valid measures of operative quality in settings where follow-up is poor (Congdon et al 2013).

**Refractive Error**

Refractive error results in an unfocussed image falling on the retina. UREs, which affect persons of all ages and ethnic groups, are the main cause of vision impairment. There are four main types of refractive errors, namely myopia, hyperopia, astigmatism, and presbyopia.

Astigmatism causes blurred or distorted vision, when the cornea or lens is not a perfectly curved shape. If left untreated, astigmatism can also cause headaches, eye strain and fatigue (tiredness) – particularly after doing tasks that involve focusing on something for a long period of time.
Hyperopia (long-sightedness) affects a person's ability to see objects close to them. People suffering from hyperopia will usually be able to see distant objects clearly, but nearby objects will be out of focus dependent on the state of accommodation of the crystalline lens. Hyperopia typically occurs when the eyeball is too short, the cornea is not curved enough or the lens is not thick enough. There are various causes of hyperopia, including age, genetics and certain underlying medical conditions, such as diabetes (where there is too much glucose in the blood). Occasionally, surgery for cataract can result in a particular but severe form of hyperopia known as aphakia, where an intraocular lens is not implanted in the eye following crystalline lens removal. Such individuals require very strong spectacles or contact lenses to correct their vision. Children are usually born long-sighted but the problem usually corrects itself as the child's eyes develop (NHS 2014).

Presbyopia is a decline in the eye's ability to focus on close objects experienced with age. It is usually addressed through the prescription of reading spectacles. Presbyopia literally means ‘ageing sight’. For a person to look at something close up, the flexible lens of the eye changes shape to provide the close focus required. However, as a person ages, the lens becomes less flexible and its ability to change shape is reduced. This inevitable loss of flexibility is called presbyopia and causes near vision to be blurred. Myopia, also known as 'short-sightedness' or 'near-sightedness', causes people to have difficulty seeing distant objects clearly (BHVI 2014).

Cases of short-sightedness can range from mild, where treatment may not be required, to severe, where a person's vision is significantly affected. The symptoms of short-sightedness often start around puberty and gradually get worse until the eye is fully grown. Most people are born slightly long-sighted, where close objects appear blurred. This is because at birth the eyes have not grown to their full length. Children are able to "accommodate", which means they can
overcome the long-sightedness. After the eyes have grown to their full length (by around eight years of age), the optical focus is normal. This is known as emmetropia. However, in short-sightedness, the eyes keep growing and become too long from front to back. This means that light doesn't reach the light-sensitive tissue (retina) at the back of the eye. Instead, the light rays focus in front of the retina, resulting in distant objects appearing blurred. Unlike long-sightedness, it isn't possible to overcome short-sightedness through lens accommodation. Short-sightedness is usually caused by a combination of genetic and environmental factors that disrupt the eye's normal growth (NHS 2014).

Figure 3 – Normal vision, nearsightedness and farsightedness (Lusby 2013)
In 2010, it was estimated that 123 million people had significant vision impairment (< 6/18 in the better eye) due to UREs affecting distance vision, including at least eight million people with blindness (< 3/60 in the better eye) (Pascolini & Mariotti 2011). In addition, 517 million people were without adequate correction for functional presbyopia in a 2005 estimate (Holden et al 2008).

Figure 4 – A teacher in Mozambique with refractive error being fitted with corrective spectacles
**Trachoma**

Trachoma is an infectious eye disease caused by the bacterium Chlamydia trachomatis, which spreads by contact with an infected person’s hands or clothing. Trachoma is endemic in 53 countries, often affecting the poorest of the poor. Approximately 110 million people live in areas where trachoma is confirmed to be endemic. Another 210 million people live in districts where trachoma is suspected but where no data are available to guide interventions. In the confirmed districts, an estimated 4.6 million people suffer from the final stages of the disease and require trichiasis surgery to prevent them from going blind. Additionally, more than 80% of the burden of active trachoma is concentrated in 14 countries, where immediate action is needed (ITI 2014).

Infections of the conjunctiva may start in early childhood. People infected with trachoma do not instantly go blind. The disease manifests gradually, with repeated infections over childhood leading to scar formation of the conjunctiva of the eyelids. This causes the eyelashes to turn inward and scratch the cornea. This may lead slowly and painfully to complete blindness. Poor people are particular vulnerable, especially those living in areas that have limited access to water and sanitation. Africa is the most affected continent. Because trachoma is transmitted through close personal contact, it tends to occur in clusters—often infecting entire families and communities (ITI 2014).

Trachoma is treatable and preventable with a multifaceted approach known as the SAFE strategy. The SAFE strategy is a comprehensive public health approach that combines treatment (Surgery and Antibiotics) with prevention (Facial-cleannliness and Environmental improvement). Antibiotic treatment will provide a short-term cure, especially when the whole community is treated, but reinfection occurs usually within six months. This is why it is essential that the full SAFE strategy be in place in trachoma-endemic communities. Even if trachoma is eliminated,
trichiasis surgery will remain necessary for the population already affected and with scarring of the conjunctiva and in-turned eyelashes (ITI 2014).

**Vitamin A Deficiency**

VAD remains a significant cause of preventable childhood blindness and increased risk of mortality among children under five years of age. Improvements have been made in recent years due to VAD programmes and increased coverage with measles immunisation. Despite this, VAD affects 190 million children under five, particularly in Africa and South East Asia with India contributing to 85% of cases in South East Asia. Biochemical VAD is of public health significance in 122 countries and clinical VAD is of concern in 45 countries (IAPB 2014).

Timely vitamin A supplementation prevents childhood blindness from VAD. Two doses of vitamin A given annually to all children aged between 6-59 months prevents their developing VAD blindness. VAD can have a range of consequences, including an increased risk of child mortality. The range of consequences are collectively known as VAD Disorders (VADD). The reason there are global programmes for control of VAD in children is because it also significantly increases under 5 mortality rates in countries where it is a public health problem. Indeed, under 5 mortality rates are now used to indicate the likelihood that whether a country has significant VAD in its population of children (IAPB 2014).

**Low Vision**

A person with low vision is one who has an impairment of visual function for whom full remediation is not possible by conventional spectacles, contact lenses or medical intervention and which causes restriction in that person’s everyday life. This definition includes, but is not limited to, those who are registered as blind and partially-sighted (RNIB 1999). Despite major
advancements in eye care, there are still a significant number of persons of all age group who can’t have their sight fully restored. The majority of these people have some vision that can be enhanced and utilised for tasks that require vision. Previous estimates suggest that there were 124 million people with low vision (Foster & Resnikoff 2005). More recent estimates suggest the number to be approximately 40–65 million (VISION 2020 2006). The number of people with low vision will increase as a result of the ageing of the world’s population, and age-related macular degeneration, glaucoma and diabetic retinopathy are increasingly important causes of low vision (VISION 2020 2006). The number of children in need of low vision care worldwide is 6 million, of these children; 4.8 million live in low- and middle-income countries. **IAPB 2014**

**Onchocerciasis/River Blindness**

Onchocerciasis is caused by infection with the filarial parasite Onchocerca volvulus, which is transmitted by the blackfly species. The vast majority of the 37 million infected people live in West, Central and East Africa, with smaller foci in Latin America and Yemen (IAPB 2014). Control measures entail larvicide spraying of blackfly breeding sites and treatment of endemic communities with drugs. The disease is endemic in 30 countries of Africa (Angola, Benin, Burkina Faso, Burundi, Cameroon, Central African Republic, Chad, Congo, Côte d’Ivoire, Democratic Republic of the Congo, Equatorial Guinea, Ethiopia, Gabon, Ghana, Guinea, Guinea-Bissau, Kenya, Liberia, Malawi, Mali, Mozambique, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, Sudan, Togo, Uganda and the United Republic of Tanzania). Currently, about 300,000 people are blind from onchocerciasis (IAPB 2014). Figure 5 indicates the exposure risk of onchocerciasis in Mozambique.
Figure 5 – Onchocerciasis exposure risk in Mozambique by district (CDCP 2006)

**Glaucoma**

Glaucoma is characterised by structural damage to the optic nerve and associated visual dysfunction that may be caused by various pathological processes (Foster et al 2002). It relates to a group of conditions that can be classified in a variety of ways, but all of which are characterised by optic nerve damage and visual field loss, secondary to retinal ganglion cell damage and death (IAPB 2014). By 2020 there will be approximately 80 million people with glaucoma, an increase of about 20 million since 2010. Furthermore, it is thought that at present over 8 million people are bilaterally blind due to glaucoma, a figure that is set to rise to over 11 million by 2020 with the increasing prevalence, unless improved screening and effective
treatment strategies are successful (Quigley & Broman 2006). It is estimated that in developed countries, half of glaucoma cases are undiagnosed. This is because it is mostly asymptomatic until late in the disease when visual problems arise. Vision loss from glaucoma cannot be recovered, and improved case-detection methods for glaucoma are needed. Glaucoma is commonly treated with daily eye-drop drugs, but adherence to treatment is often unsatisfactory. As a usually asymptomatic and chronic disease, glaucoma has similar treatment challenges to chronic systemic diseases (Quigley 2011).

**Diabetic Retinopathy**

Diabetes mellitus is becoming a global epidemic. In 2013, there were 382 million people with diabetes. By 2035 this will rise to 592 million (IDF 2013). Diabetes increases the risk of a range of eye diseases, but the main cause of blindness associated with diabetes is diabetic retinopathy, which damages blood vessels inside the retina at the back of the eye. It commonly affects both eyes and can lead to vision loss if it is not treated. Poorly controlled blood sugars, high blood pressure and high cholesterol increase the risk of developing diabetic retinopathy. Every person with diabetes is at risk of developing diabetic retinopathy. More than 75% of people who have diabetes for more than 20 years will have some form of diabetic retinopathy (WHO 2005). While DR is not currently the primary cause of avoidable blindness, it has the capacity to become the leading cause of blindness in the next 20 years and it will affect the poorest people most - already 80% of people with diabetes live in low-middle income countries (IDF 2013).

**Age Related Macular Degeneration**

Age Related Macular Degeneration (ARMD) is a disease affecting the central area of the retina (macula) at the back of the eye. In the early stages of the disease lipid material accumulates in
deposits underneath the retinal pigment epithelium. These deposits are known as drusen, and can be seen as pale yellow spots on the retina. The pigment of the retinal pigment epithelium may become disturbed, with areas of hyperpigmentation and hypopigmentation. In the later stages of the disease, the retinal pigment epithelium may atrophy completely. This loss can occur in small focal areas or can be widespread (geographic atrophy). In some cases, new blood vessels grow under the retinal pigment epithelium and occasionally into the subretinal space. Haemorrhage can occur which often results in increased scarring of the retina. The early stages of the disease are in general asymptomatic. In the later stages there may be considerable distortion within the central visual field leading to a complete loss of central visual function. Approximately 5% of blindness globally is due to AMD (Pascolini & Mariotti, 2011). It is estimated that globally 196 million people will have AMD in 2020, increasing to 288 million in 2040 (Wong et al 2014).

2.7 The Prevalence of blindness and VI

Central to the achievement of the development agenda is the provision of appropriate and accessible health care, included in which is the provision of eye health services. The following section discusses blindness and VI in depth. After a brief introduction, it covers the causes and consequences to blindness and VI, and explains why the importance of eye health.

The World Health Organization (WHO) estimated that 285 million people are estimated to have VI worldwide. Of these, 39 million are blind and 246 are visually impaired (WHO 2014 b). Despite a reduction in VI from infectious diseases in the last 20 years, the global south still bears the burden of eye health problems disproportionately, with 90% of those people with VI living in developing countries. Globally, URE are the main cause of VI accounting for 43% of all cases.
Cataracts remain the leading cause of blindness. With evidence suggesting that as much as 80% of all VI can be either avoided or cured, there is reason to be optimistic about eye health in the future (WHO 2014 a).

However, NCDs and injuries, including blindness and VI accounted for 35% of illnesses in Africa in 2005; these figures will rise to 65% by 2020 (WHO 2008). Despite advances in disease control as well as improvements in capacity and advocacy efforts to combat blindness and VI, without further interventions, the magnitude of avoidable blindness and VI will continue to escalate. The problem will be exacerbated by a combination of increasing global population and increasing life expectancy, and the inexorable rise in resultant eye health conditions such as refractive error and cataract, whose prevalence is linked to aging (West & Sommer 2001, Frick & Foster 2003).

Although prevalence varies widely, in 2001 the prevalence of blindness in Africa has been estimated in one study to be approximately 1% (Lewallen & Courtright 2001). In excess of 26 million people in Africa are also thought to have VI, representing 3.26% of the population (Pascolini & Mariotti 2011). Evidence from a 52 country study found that the prevalence of blindness has decreased from 1.9% (95% CI 1.5% to 2.2%) in 1990 to 1.3% (95% CI 1.1% to 1.5%) in 2010, and that moderate/severe vision impairment (MSVI) decreased from 5.3% (95% CI 0.2% to 0.3%) to 4.0% (95% CI 0.2% to 0.3%) over that period.

However, there was a 16% increase in the absolute numbers with blindness and a 28% increase in those with MSVI. The major global causes of blindness in 2010 were established as cataract (35%), other/unidentified causes (33.1%), refractive error (13.2%), macular degeneration (6.3%), trachoma (5.2%), glaucoma (4.4%) and diabetic retinopathy (2.8%). The data also suggested some gender disparities between those suffering, with the prevalence of MSVI in Africa being
3.8% (95% CI 3.1% to 4.7%) for men and 4.2% (95% CI 3.6% to 5.3%) for women (Naidoo et al 2014). The major causes of VI in 2010 were established as URE (43%) and cataract (33%) (Pascolini & Mariotti 2011).

Figure 6 – Prevalence of people with VI per 100 (WHO PBDU 2010)

The technical categories for vision loss as described in Table 3, as defined by leading ophthalmologists and optometrists, who form the Vision Loss Expert Group (VLEG).
Table 3 - Vision loss categories (Bourne et al 2013)

<table>
<thead>
<tr>
<th>Vision loss category</th>
<th>Definition by visual acuity* in the better eye</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild VI</td>
<td>&lt;6/12 but better or equal to 6/18</td>
</tr>
<tr>
<td>Moderate VI</td>
<td>&lt;6/18 but better or equal to 6/60</td>
</tr>
<tr>
<td>Severe VI</td>
<td>&lt;&lt;6/60 but better or equal to 3/60</td>
</tr>
<tr>
<td>Near VI</td>
<td>&lt;6/12 but better or equal to 3/60 for near, but 6/12 or better for distance</td>
</tr>
<tr>
<td>Distance blindness</td>
<td>&lt;3/60 and/or a visual field of no greater than 10° in radius around central fixation</td>
</tr>
</tbody>
</table>

* Snellen visual acuity or the equivalent calculated from published LogMAR values.

2.8 The social and economic impact of addressing blindness and VI

In the 2004 update of the GBD Study, cataracts and refractive errors combined accounted for 7% of the total YLD. In low and middle income countries, refractive error and cataracts were the second and fifth most common causes of YLD, accounting for 5% and 3% of the total, respectively. In high-income countries, refractive errors accounted for 4% of the total YLD (Bourne et al 2012).

Although there is a paucity of evidence illustrating the social and economic impact of addressing blindness and VI, evidence from the studies that do exist suggest that they impose a substantial socioeconomic burden worldwide (Frick & Foster 2003, Frick et al 2005, Smith & Smith 1996). The substantial burden was the result of high prevalence and the disability weights (DWs) used. Global estimates have been found to have significant uncertainties that will be reduced as more
population based studies become available (WHO 2012). In recent times, prevalence estimations have become more refined and DWs have been revised. This is discussed in detail in subsequent chapters. However, the results from these earlier studies are still important in terms of context. They illustrate how blindness and VI can limit an individual’s ability to contribute to the economy, constrain progress in education, reduce literacy, inhibit motor development, hamper access to information, impede career opportunities and it could be argued consequently reduce life expectancy (Holden et al 2000).

If the main wage earner of a family becomes visually impaired, they may be forced to stop working, or rely on a sighted family member who might normally be working, for assistance and care. If the carer is a child who forgoes school to stay and look after the person with VI, the negative consequences can be long-term and intergenerational (Metcalfe 2011).

Blindness and VI can also lead to social exclusion, isolation and may impact negatively on a person’s social status. Also, people who are blind may require a person with good vision to assist them. It has been estimated that for each person who is blind, 10% of a person’s time who has good vision would be occupied providing care (Frick & Foster 2003).

Disability has a bidirectional link to poverty. Disability may increase the risk of poverty, and poverty may increase the risk of disability (Jenkins & Rigg 2003). A growing body of empirical evidence indicates that those people who have disabilities are more likely to experience economic and social disadvantage than those without disability. The families of people with disabilities may also be more likely to experience economic and social disadvantage. Poverty is both a cause and a consequence of blindness (WHO 2011).
Blindness, VI, and the lack of eye health provision are too often the result of social, economic and developmental challenges of the global south. Preventable blindness and VI is often the result of a combination of factors such as poverty, lack of education, inadequate health-care services and the lack of opportunity for people to control or influence their health care. While there is an increasing recognition of the need to highlight the link between poverty, development and health care, more research is needed to explain the link and explore the causality (Naidoo 2007). Country level evidence from Pakistan found that blindness is associated with poverty and that lower access to eye care services was a contributory factor. Gilbert et al (2008) argue that if strategies are put in place to reduce poverty, then blindness will be reduced.

Blindness is more prevalent in impoverished countries (Dandona & Dandona 2001 b). It is shown to be five times more prevalent in impoverished countries than in rich countries (Kuper et al 2008). There is a clear correlation between increased prevalence of blindness and poor economic development (Ho & Schwab 2001). Some blinding conditions, such as trachoma, are a direct consequence of poverty, which thrives in poor communities with limited or no access to water and sanitation (Kuper et al 2008).

Poverty may also restrict access to health services, prolonging the burden of disease. Evidence from Kenya, the Philippines and Bangladesh shows people who were blind due to cataract were found to be poorer than those with normal sight. Levels of literacy and education were also lower among those that were blind, indicating disadvantage. Also, as cataract sufferers tend to be elderly they may be suffering from multiple disabilities, compounding their poverty. Inability to afford cataract surgery is cited as the major barrier to the uptake of surgery (Kuper et al 2008). High health care costs may exacerbate poverty. In China, ill health increases medical
expenditure, detracting from family spending in other areas, such as food and education (Wang et al 2006).

Children blinded at birth or during childhood incur a higher economic cost both to their families and to society over the course of their lifetime (Smith & Smith 1996). Interventions to reduce blindness can allow individuals to be more economically productive for their remaining natural life (Frick et al 2005). The costs of blindness are demonstrably high both for society and individuals who are blind (Smith & Smith 1996).

Data from the USA found that blindness and VI are among the costliest health conditions there, costing an estimated $139 billion in 2013. Based on ever-increasing healthcare costs and an aging population, this cost is set to continue to grow. The indirect costs of low vision greatly increase the total burden beyond the healthcare sector (Wittenborn & Rein 2013).

Evidence suggests blindness and VI have a negative impact on economic productivity. The cost of blindness and VI will depend upon how many blind people are economically productive, as well as on how many would enter economic activity if they were able to do so (Smith and Smith 1996). The estimated productivity loss associated with blindness ranges in different economic analyses.

A study in India assumed that 20% of all those who are blind are economically productive at 25% the productivity level of a member of the labour force. The remaining 80% of blind people were assumed to not be economically productive (Shamanna et al 1998). A study focused on global productivity loss due to URE used DWs for vision disorders (0.600 for blindness, 0.244 to 0.282 for moderate/severe VI (previously termed “low vision”). No personal economic productivity for cases 15 years of age or under (Smith et al 2009). The DWs in the updated GBD
study are lower. This is discussed at a later point in this thesis. While there is a consensus in the literature that blindness and VI can impact on economic productivity, there is no agreed upon level of impact.

‘Economic blindness’ refers to people with low vision (as opposed to being fully and irreversibly blind) who may be at a disadvantage in completing tasks and thus possibly face unemployment (West & Sommer 2001). Adults without good reading vision will be at an automatic economic disadvantage and potentially limited in the type of employment available to them. To ensure maximum productivity from an economically developing population, age related conditions must be adequately addressed (Patel et al 2006).

Economic blindness is likely to increase as age related low vision becomes more prevalent as people live longer and also as societies become more technologically advanced (West & Sommer 2001). It is reported that workers using computers make more frequent reports about vision difficulties than any other problem. Symptoms were found to relate to visual environmental factors including glare, lighting, screen resolution and work arrangement (Daum et al 2004, Sheedy 1992).

Computers are becoming an entrenched part of everyday life all over the world. Ocular symptoms related to computer use include eyestrain, tired eyes, irritation, redness, blurred vision, and double vision. Collectively these symptoms are referred to as computer vision syndrome. Computer vision syndrome symptoms may be the cause of ocular (ocular-surface abnormalities or accommodative spasms) and/or extraocular (ergonomic) etiologies. The major contributor to computer vision syndrome symptoms is dry eye. More research is needed to define the processes that cause computer vision syndrome and to develop and improve effective treatments that successfully address these causes (Blehm et al 2005). As economies become more reliant on
computers, vision disorders associated with using them may increase, adding to the existing burden.

Research from the USA found that the annual financial burden of major adult vision disorders exceeds $50 billion: $35.4 billion to the U.S. economy and $15.9 billion to individuals with vision problems and their caregivers (Prevent Blindness America 2007). The possibility of lost employment may act as an incentive, especially to younger patients with VI, who may calculate the economic advantage of good vision and actively seek eye health as required. They may be willing to invest a tiny proportion of what otherwise maybe in lost wages in sight saving spectacles, surgery or medicine (Sommer 1995).

A study that estimated non-medical costs related to VI in France, Italy, Germany and UK found that the total annual costs for persons with VI were estimated at €10,749 million (equivalent to US$ 14,633 million) in France, €9,214 million (US$12,544 million) in Germany, €12,069 million (US$16,430 million) in Italy and €15,180 million (US$20,665 million) in the UK (Lafuma et al 2006). The main cost components of VI in the community were ‘loss of income’ (23–43% of community costs), ‘burden on carer’ (24–39%) and ‘paid assistance’ (13–29%) (Lafuma et al 2006).

Total non-medical costs associated with VI are evidently considerable. The economic consequences of VI lie beyond healthcare systems, and that VI has a considerable negative impact on productivity. Considering the non-medical social dimensions of VI related to the consequent incapacity and dependency should encourage payers to finance health innovations that aim to preserve vision (Lafuma et al 2006).
Vision disorders were found to cost Australia an estimated A$9.85 billion in 2004 (equivalent to US$9.25 billion at current exchange rates). Vision disorders rank seventh and account for 2.7% of the national loss of wellbeing. Direct health system costs total A$1.8 billion. They have increased by A$1 billion over the last 10 years and will increase a further A$1–2 billion in the next 10 years. Cataract, the largest direct cost, takes 18% of expenditure. The health system costs place vision disorders seventh, ahead of coronary heart disease, diabetes, depression, and stroke. Indirect costs, A$3.2 billion, include carers' costs, low vision aids, lost earnings, and other welfare payments and taxes (Taylor et al 2006).

A study that quantified the total economic cost of VI in Japan used prevalence-based approach, using data on VI, the national health system, and costs to capture the economic impact of VI. It found that in 2007, VI affected more than 1.64 million people in Japan and cost US $72.8 billion across the economy, equivalent to 1.7% of Japan's GDP. The loss of well-being was reported to cost US $48.6 billion. Direct health system costs were US $11.1 billion. Other financial costs were US $13.1 billion, including productivity losses, care takers' costs, and efficiency losses from welfare payments and taxes. Community care was the largest component of other financial costs and was composed of paid and unpaid services that provide home and personal care to people with VI (Roberts et al 2010).

A study was undertaken to identify the potential effect on global economic productivity of successfully implementing VISION 2020 initiatives. It used existing data and assumptions about blindness prevalence, national populations, GDP per capita, labour force participation, and unemployment rates were used to project the economic productivity loss caused by blindness. The results suggest that without extra interventions, the global number of blind individuals would increase from 44 million in the year 2000 to 76 million in 2020. A successful VISION
2020 initiative would result in only 24 million blind in 2020 and lead to 429 million blind
person-years avoided. A conservative estimate of the economic gain is $102 billion. The results
of this study indicate that the VISION 2020 initiative has the potential to increase global
economic productivity (Frick & Foster 2003).

A systematic review considered all research prior to May 2012 that focused on the direct and
indirect costs of VI and blindness. A total of 22 studies were included. The mean annual
expenses per patient were PPP US$12,175–14,029 for moderate VI, PPP US$13,154–16,321 for
severe VI and PPP US$14,882–24,180 for blindness, almost two fold the costs for non-blind
patients (Köberlein et al 2013). Informal care contributed to costs, with the time spent by
caregivers increasing from 5.8 h/week (or US$ PPP 263) for persons with vision >20/32 up to
94.1 h/week (or PPP US$ 55,062) for persons with vision ≤20/250 (Köberlein et al 2013).

Blindness and VI caused considerable indirect costs due to productivity losses, premature
mortality and dead-weight losses. Blindness and VI was found to cause a considerable economic
burden for affected persons, their caregivers and society at large, which increases with the degree
of VI (Köberlein et al 2013).

Data from Britain suggests that there was an association between people with VI and those
suffering depression, compared with people with good vision (Evans et al 2007). Evidence also
indicates an association between VA and quality of life (Seland et al 2011).

Using published data on disease prevalence rates, health care expenditures and other economic
data, a study estimated that the total cost of VI globally was estimated at $3 trillion in 2010, of
which $2.3 trillion was direct health costs. This burden is projected to increase by approximately
20% by 2020. VI is associated with a considerable disease burden. Prevalence of VI must be
reduced through prevention and treatment. If prevalence is not reduced, the burden of VI will increase alongside global population growth (Gordois et al 2012).

Analysis that quantifies the benefits of eliminating blindness and VI in terms of the benefit that can be achieved from the additional investment made to eliminate avoidable blindness and VI, suggests that the total value of the combined economic and health benefits that have been quantified in monetary terms is $843.5 billion accrued globally over a ten year period, from 2011 to 2020. When the benefits are compared to the total cost of eliminating avoidable blindness and VI, the benefit to cost ratio is 2:1. In terms of people with VI returning to employment, the benefit is estimated at $670 billion, with an additional benefit of $43.5 billion being estimated to accrue to carers of avoidably blind and visually impaired persons. Regarding the benefits, 61% of the total would be accrued by the developing world (FHF 2013).

2.9 The social and economic impact of addressing URE

URE is recognised as a priority public health condition VISION 2020 (IAPB 2014 a). It is a priority, not just because of the burden of blindness and VI that it is responsible for, but also because of how easily and affordably it can be treated (Holden & Resnikoff 2002). URE has been shown to have negative consequences on individuals and societies. For example, URE has been shown to have a negative impact on education outcomes. The impact of URE on education can result in an adverse effect on a child’s professional development later in life (Ebri et al 2007). There is evidence that early treatment of children with refractive error can improve educational outcomes (Mathers et al 2010). Results from a randomised trial in Western China indicate that wearing eyeglasses increased test scores by 0.41 or more standard deviations, equivalent to 0.9 additional years of schooling (Glewwe et al 2014).
URE is also shown to have a negative impact on job satisfaction, productivity, and well-being. Analysis of data from across 11 European countries and Israel found that respondents with lower levels of self-reported general eyesight were significantly less satisfied with their jobs, felt they had less freedom to decide, less opportunity to develop new skills, less support in difficult situations, less recognition for their work, and an inadequate salary (Mojon-Azzi et al 2010). Evidence suggests that URE limits employment opportunities and reduces productivity (Holden & Resnikoff 2002, Resnikoff et al 2008).

To address the shortfall in human resources needed to address URE, it is estimated that approximately 47,000 additional staff are needed who are focused on clinical refractions. They would need to be supported by 18,000 additional ophthalmic dispensers, would need to be trained. The investment needed to establish the educational institutions to train these staff was estimated to be US$ 104 million. An additional US$ 46 million would cover continuing professional development for new personnel for the first 5 years of their careers (Fricke et al 2012).

The total educational costs were US$ 543 million, which includes the costs of education, the cost of educating student refractive care personnel and student ophthalmic dispensers and the cost of continuing professional development for all new personnel for 5 years. The total estimated cost for educating the new personnel, plus providing the service delivery facilities needed to deal with the backlog and all incident cases of distance and near vision impairment resulting from URE was US$ 20,045 million (Fricke et al 2012).
2.10 Gender, blindness and VI

Blindness and VI affects a disproportionately high number of women and girls. Close to two-thirds of the world’s blind are women. In the industrialised countries this is because women live longer than men. The larger number of elderly females contributes substantially to the excess female blindness in countries where women have a higher life expectancy than men. Age related macular degeneration, a disease with no effective treatment and the most common cause of blindness in industrialized countries, affects mostly those over 70 years (Courtright 2002).

In the global south the situation is different. In Asia and Africa, the major cause of blindness is cataract, which can be cured by surgery. Research indicates that women account for between 53% and 72% of all people living with cataract, but they do not receive surgery at the same rate as men. Women with cataract are much less likely to have cataract surgery than men with cataract. It is estimated that cataract blindness would be reduced by approximately 12.5% if women received cataract surgery at the same rate as men (Courtright 2002). More recent research has shown that gender inequity in use of cataract surgical services persists in the low- and middle-income countries. Blindness and severe VI from cataract could be reduced by around 11% in the low- and middle-income countries if women were to receive cataract surgery at the same rate as men. Additional effort globally is needed to ensure that women receive the benefits of cataract surgery at the same rate as men (Lewallen et al 2009).

Trachoma, another important cause of blindness in developing countries, is also more common in women than in men. This is explained by women and older girls typically being the primary childcare providers, exposing them to increased risk of acquiring active trachoma from young children. Surveys carried out in trachoma-endemic areas show that about 75% of adults with
trachomatous trichiasis are female. Simple surgery can prevent blindness at this stage for patients who can access it (Courtright 2002).

As well as being exposed to causative factors such as infections, evidence suggests that women of all ages (including children) are more frequently exposed to malnutrition. Awareness of the gender disparity with blindness and VI is not enough. Political will and social action are needed to address gender inequities in use of eye care services (Seva 2012).

Access to eye health services are often different for men and women. Barriers may vary depending on the context and location. They include lack of financial resources, inability to travel to facilities, lack of information about services, and differences in the perceived value of services. Women may be discouraged from wearing glasses in some societies; if cataract surgery does not have a good refractive outcome women are more likely to be functionally blind than men after surgery (Courtright 2002).

Research from India suggests that there are significant gender differentials in the seeking of eye care across different dimensions. For example females have a lower incidence of perfect vision and are more likely to have VI. Some differences between male and female admittance times for patients needing cataract surgery were recorded, with women being less likely to be admitted to hospital earlier. This is perhaps due to reluctance of the individual or family to admit women into hospitals unaccompanied. However, no gender differential in going for follow-up after surgery was recorded (Jayaraman et al 2012).

Results also indicate that there are no significant gender differences between males and females in the case of an asymptomatic disease such as glaucoma. However, when a disease is linked to the direct perception of it, there are significant differences between the health outcomes of male
and female, suggesting that males appear more responsive to their perceptions of ill-health. No evidence for females receiving differential care at the medical facility was found, indicating that inequality exists at the level of access rather than the level of treatment (Jayaraman et al 2012).

Unless special efforts to ensure eye services for women and girls, the correctable disparities in blindness prevalence between men and women will continue (IAPB 2014).

For blindness prevention programmes to successfully address gender inequalities, Courtright (2002) argues the following must be considered:

- Awareness of the problem is needed to generate political will to address sex differentials and gender inequities in use of eye care services.
- At the local level it is important to identify the barriers that prevent women from receiving eye care services and to design gender-sensitive programmes to reduce these. Peer motivators (women talking to other women) are likely to be more effective than health workers in promoting use of eye care services including surgery.
- National and local prevention of blindness programmes should monitor cataract surgical coverage and trichiasis surgical coverage rates by sex as well as monitor outcome of surgery by sex. Discrepancies found should be investigated.
- Global awareness of and local approaches to improving gender equity in eye care service use will be critical steps in eradicating avoidable blindness.

With regards to planning eye health programmes, it is recommended that planners use participatory methods. If they direct most attention to the community level, they will gain long term trust and to involve community members in planning and providing prevention and treatment strategies. Programme planners should especially encourage women to be engaged
with the process. This may be a difficult and sensitive process requiring an understanding of local social, political and economic issues in their historical context. Planners need to be aware that women may not have decision making power within communities. Programmes designed to increase utilisation of services by women, therefore, may need to consult and include the people (often husbands or male community elders) who have decision-making authority. In communities where women have less autonomy, they may have to get permission from husbands, in-laws or other family members before seeking health care. Even if they are given permission to seek health care, someone may be required to accompany them to a health facility (Singh et al 2012).

More research is needed to ascertain the impact of gender on eye health decision making. Some research has been done into women’s empowerment and reproductive health. For example, research in Asia indicates that strengthening women’s empowerment has a positive impact on contraceptive use, lower fertility, and longer birth intervals. Little is known about the association of women’s empowerment with fertility desires in Africa (Upadhyay & Karasek 2010). The goal is to empower communities to meet their eye care needs. In addition, planners need to be aware of many different approaches to promote health education in a gender sensitive fashion within communities (e.g., school child health programmes, collaboration with traditional healers, women’s groups, local service groups) (Courtright & Bassett 2003).
2.11 The global political landscape - blindness and VI

In response to the burden of blindness and VI, the WHO together with the International Agency for the Prevention of Blindness (IAPB) launched VISION 2020 in 1999. VISION 2020 is a global initiative that aims to eliminate avoidable blindness by the year 2020. It works as a partnership that provides guidance, technical and resource support to countries that have formally adopted its agenda and are working to eliminate the main causes of all preventable and treatable blindness as a public health issue by the year 2020. The core strategies of VISION 2020 are based on disease control, training human resources and developing infrastructure and technology (IAPB 2014 a).

As described above, the potential for progress by pursuing the goals of VISION 2020 and MDGs is clear. Synergy between the global initiatives can be realised to achieve positive health outcomes. VISION 2020 initiatives can contribute towards the MDG of universal primary education in four ways:

- Reducing blindness in adults, so that sighted children do not need to stay at home as carers
- Preventing blindness in children
- Ensuring that children with significant UREs are identified and given the spectacle correction they need
- Linking eye care services to special education or other educational services for children who are visually impaired or blind.

Demonstrating to governments that a commitment to VISION 2020 will help them work towards the MDGs, rather than divert resources away from them, can be a way to convince governments to become more actively involved in the prevention of blindness and to allocate the necessary
financial resources (Faal & Gilbert 2007). As described above, the only MDG without a direct link to eye health is MDG 5 - Improve maternal health. It could be argued that as improving eye health reduces poverty, improves education and increases earning potential, this will in turn improve maternal health – however, it would be hard to attribute this improvement to eye health improvements alone, which would make reporting against the targets problematic.

With all the other MDGs, considerable progress has been achieved, as well as synergy between VISION 2020 and the MDGs as global initiatives, especially on MDG 1—the reduction of poverty. Progress is being made towards reducing poverty, as well as reducing the numbers of blind people. A review of the MDGs has identified the need to address disparities within and between countries. The collection of data and information will allow the identification of these disparities within and between countries. As well as the quantity of services and programmes, a focus on quality will need to be prioritised. NCDs are emerging as a challenge to both the MDG and VISION 2020 targets. To continue the current momentum beyond 2015, there will be need for both initiatives to continue to work in synergy to address present and emerging challenges (Faal 2012).

An IAPB Work Group has been formed and aims to bring together the voices and harness the combined strengths of the members to work on the Post-2015 agenda. The aim is to promote a new framework that is conducive to improving health and eye health systems (for prevention, promotion, treatment, and rehabilitation), and promoting the rights of persons with disabilities, including those with VI (IAPB 2014 b).

In May 2013 the 66th World Health Assembly unanimously approved the Global Action Plan (GAP) for the Prevention of Avoidable Blindness and Visual Impairment 2014-2019 - Towards Universal Eye Health (WHO 2013). The goal of the plan is to reduce avoidable VI as a global
public health problem and to secure access to rehabilitation services for those suffering VI. To achieve this goal, access to comprehensive eye health services must be improved and integrated into health systems. The GAP’s areas of focus are the generation of evidence on the burden and challenge of VI, and to use the data for advocacy. The GAP also emphasises the importance of integrated national eye health policies, plans and programmes. Multi-sectoral engagement is encouraged and effective partnerships to strengthen eye health (WHO 2013).

In 2010 the WHO published a report that maps out what countries can do to modify their financing systems so they can move more quickly towards the goal of universal coverage, while sustaining gains that have already been achieved (WHO 2010 b). It builds on new research and lessons learnt from country experience. It provides an action agenda for countries at all stages of development and proposes ways that the international community can better support efforts in low income countries to achieve universal coverage and improve health outcomes.

The report explains how people rate health one of their highest priorities, in most countries behind only economic concerns, such as unemployment, low wages and a high cost of living. As a result, health can become politicised as governments try to meet peoples’ expectations.

Promoting good health and sustaining it can be done in many ways, including some methods that lie outside the confines of the health sector, including the circumstances in which people grow, live, work, and age. However, timely access to health services (including promotion, prevention, treatment and rehabilitation) will be critical. For this to be achieved a well-functioning health financing system is needed. This will determines whether people can afford to use health services when they need them, and indeed if the services exist in the first place (WHO 2010 b).

The report details how three fundamental, interrelated problems restrict countries from moving closer to universal coverage. The first is the availability of resources. Universal access is still a
goal of the richest countries. In the poorest countries, few services are available to all. The second barrier is an overreliance on direct payments at the time people need care. These include over-the-counter payments for medicines and fees for consultations and procedures. Even with insurance systems, this barrier persists. Having to pay (whether it be formally or informally) prevents millions of people receiving health care when they need it. For those who do seek treatment, it can result in severe financial hardship, even impoverishment. The third barrier is the inefficient and inequitable use of resources. Currently 20–40% of health resources are being wasted. Reducing this waste would greatly improve the ability of health systems to provide quality services and improve health. Improved efficiency often makes it easier for the ministry of health to make a case for obtaining additional funding from the ministry of finance. Countries must raise sufficient funds, reduce the reliance on direct payments to finance services, and improve efficiency and equity. It is clear that every country can do more in at least one of the three key areas to move towards universal access (WHO 2010 b).

![Figure 7 – The three dimensions to consider when moving towards universal coverage (WHO 2010 b)](image-url)
With regards to national government to achieve universal eye health, the GAP advocates for the following action:

- Developing comprehensive eye care services offering a breadth of services covering the range of causes of vision impairment, from promotion, prevention to rehabilitation and care.
- Integrating eye health into health systems by attending to the six building blocks of a health system according to WHO: governance, health financing, service delivery, human resources, medicines and technologies, and information
- Develop inclusive access.
- Ensure cost or payment is not a barrier to access (WHO 2013).

As a WHO Member State, Mozambique is committed to improving the eye health of its population. The National Eye Health Plan in Mozambique expired in 2010. In line with the VISION 2020 priorities, the purpose of the plan was to reduce avoidable blindness in Mozambique through the creation and promotion of quality, maintainable and accessible eye health services for the whole population. As well as considering the other major causes of blindness and VI, the plan states that the lack of refraction services and the lack of provision of affordable spectacles will impact severely on the educational and employment potential of disadvantaged communities (MISAU 2007).

Although that plan has expired, a replacement plan is currently being drafted and Mozambique was selected for special praise regarding its commitment to national planning by the IAPB at a board meeting in March 2014 (IAPB 2014 a). The Ministry of Health is supported in the drafting
of the new plan by the Mozambique Eye Care Coalition, which comprises of non-government organisations and stakeholders in eye health, who offer financial support and technical expertise.

2.12 Conclusion

This chapter served to contextualise the research by providing information on a range of relevant topics including public health. As well as a national approach, it also summarises the global position, describing the MDG era that is coming to an end, as well as discussing what might replace it. The GBD was explained as well as the highly relevant subject of gender, which data would suggest requires further attention regarding its impact on blindness and VI. The main causes of blindness and VI are presented, as is the body of evidence that focuses on the resulting social and economic impact. The social political landscape, which any approach to address blindness and VI must fit into, was also explained in detail. The purpose of the chapter was to present a solid contextual foundation, upon which the rest of this thesis can be built.
Chapter 3. Mozambique – history, health, and education

3.1 Introduction

This chapter introduces the country of Mozambique and its people. It offers historical explanation for some of the challenges the country faces today. To foster a deeper understanding of Mozambique, it provides geographic, economic and demographic information. It goes on to analyse Mozambique’s human development status, including the situation regarding health, education and the economy.

3.2 Background to Mozambique

The Mozambican people have had contact with Muslim and European traders for nearly 1000 years. Their history is given a unity by the influence of commerce and seaborne trade. Mozambique consists of a series of ancient sea and river ports with their commercial hinterlands. The voyage of Vasco da Gama around the Cape of Good Hope in 1498 marked the Portuguese entry into trade, politics, and society of the region. For the next 500 years, the Portuguese dominated the region, establishing trading posts and forts. They displaced the Arabic commercial and military hegemony, and the harbours became regular ports of call on the new European sea route to the east. Although its frontiers were drawn in 1891, Mozambique did not become a unified state till the 1930s (Newitt 1994). Under the Portuguese colonial administration Mozambique provided railway and port facilities for South and Central Africa while large areas became in effect labour reserves. A thriving plantation economy also developed, the country becoming a leading producer of cash crops (Newitt 1994).
Mozambique was a Portuguese colony until it came to independence after a decade-long liberation war. A liberation movement, called The Front for the Liberation of Mozambique (FRELIMO), managed to build wide international support thanks to its diplomatic skills. Portugal, a member of NATO, was backed by the West, particularly the United States. But Frelimo won support from both the Soviet Union and China as well as from the Nordic states and progressive movements in the US and Europe. After independence, such support continued, and Mozambique became a one-party state, following a socialist and self-proclaimed "Marxist-Leninist" line. Upon independence, Mozambique had very few skilled or educated people, and its ministries, farms, and factories were abandoned and often sabotaged by the departing Portuguese. Thus the country became dependent on skilled foreigners, called cooperantes, or on outside support from the socialist bloc; thousands of secondary school pupils, for example, were educated in Cuba, USSR or in East Germany (Renzio & Hanlon 2007).

In the period after independence, Mozambique’s development fell victim to South Africa's attempts to destabilise its neighbours, and its fragile institutions were broken down by banditry and drought (Newitt 1994). Following independence from Portugal in June 1975, the country underwent a civil conflict that ended in 1992. The first democratic elections were held in 1994. FRELIMO came to power and have remained as the dominant political force in the country ever since (World Bank 2014 a).

Mozambique had a population of 25.83 million in 2013 and a population growth rate of 2.3% per annum. Life expectancy is 50 years and 54.7% of the population live in poverty (World Bank 2014 a). Gross Domestic Product (GDP) adjusted for Purchasing Power Parity (PPP) was $28.15 billion in 2013. The GDP real growth rate was estimated to be 7% in 2013, ranking Mozambique
as having the 19th highest rate in the world. GDP adjusted for PPP per capita was $1,200 in 2013 (CIA 2014).

Despite the high growth rates, Mozambique remains one of the world's poorest and least developed countries. It remains heavily dependent on foreign aid. Much of Mozambique’s economy was devastated by almost three decades of war during which millions of Mozambicans were displaced and many thousands killed or maimed by armed strife. Meaningful reconstruction could start only after the first multi-party election, in October 1994. Natural disasters including floods and draughts have also restricted the economy. While economic growth has been impressive in recent years, Mozambique is starting from a very low base and it is important to consider growth rates in context.

Figure 8 – Mozambique’s global position (FWM 2014).
Figure 9 – Map of Mozambique (Vidiani 2014).
3.3 Mozambique and human development

The United Nations Development Programme (UNDP) is the United Nations' organisation advocating for change and connecting countries to knowledge, experience and resources to help people build a better life. Since the first report was published in 1990, each annual Human Development Report has focused the global debate on key development issues, providing new measurement tools, innovative analysis and often controversial policy proposals. Each report has featured an updated version of the Human Development Index (HDI) (UNDP 2014).

The HDI combines the indicators of life expectancy, educational attainment and income in order to rank development. In 2013, Mozambique was ranked 185 out of 187 countries on HDI. However, Mozambique was cited as a country whose improvements on the HDI stood out relative to the performance of peers between 1990 and 2012. Mozambique, like many other countries in the global south, still faces formidable challenges and has extreme poverty, but it has demonstrated how pragmatic policies and a commitment to human development can release the opportunities latent in their economies, facilitated by globalisation (UNDP 2013).

The 2013 Human Development Report focused on the rise of the South and human progress in a diverse world. It detailed how in the 21st century, the global community is witnessing a profound shift in dynamics, driven by the fast-rising new powers of the developing world. It notes how China has overtaken Japan as the world’s second biggest economy, lifting hundreds of millions of people out of poverty in the process. India is reshaping its future with new entrepreneurial creativity and social policy innovation. Brazil is raising its living standards by expanding international relationships and antipoverty programmes that are emulated worldwide. The rise of
the South is not limited just to these few countries. Indonesia, Mexico, South Africa, Thailand, Turkey and other developing countries, including Mozambique, are developing fast.

Mozambique is one of 40 developing countries that was identified by the report that has done better than expected in human development in recent decades, with their progress accelerating markedly over the past 10 years (UNDP 2013).

Data from successive Human Development Reports indicate that most people in most countries are doing better in human development than they were in the past. Globalisation, advances in technology and higher incomes should lead to longer, healthier, more secure lives. However, many people remain vulnerable. Improvements in living standards can quickly be undermined by a natural disaster or an economic slump. Political threats, community tensions, crime and environmental damage all increase individual and community vulnerability.

The 2014 UNHD report focuses on vulnerability and resilience. Data indicates that human development progress is slowing down and is increasingly precarious. For example, as globalisation brings benefits to many, it also creates new risks. Increased volatility has become normal. As financial and food crises ripple around the world, there is a growing worry that people and nations are not in control over their own destinies and thus are vulnerable to decisions or events elsewhere (Malik 2014).

While Mozambique has improved in terms of human development in recent years, it is clear it still has a lot of vulnerable people. In 2014, Mozambique was ranked 178th out of 187 countries (UNDP 2014). While this change in ranking appears to suggest improvements in human development, caution is urged in interpreting this result. The UNDP states that comparing rankings with those of previously published reports may be misleading due to revisions and updates of the underlying data and adjustments to goalposts. This does not mean that the UNDP
data are not useful. Despite Mozambique remaining a country with low human development, between 1980 and 2013, Mozambique’s HDI value increased from 0.246 to 0.393, an increase of 59.6% or an average annual increase of about 1.43%, which is all positive news in terms of improving human development. Between 1980 and 2013, Mozambique’s life expectancy at birth increased by 7.4 years, mean years of schooling increased by 2.5 years and expected years of schooling increased by 4.7 years. Mozambique’s Gross National Income (GNI) per capita increased by about 71.1% between 1980 and 2013 (UNDP 2014).

The 2014 report states that countries acting alone can do much to progress human development, but cautions that national action can go only so far. In an interconnected world, international action is required to make and sustain change. The availability of public goods will contribute to progress (Malik 2014). Public goods are those which are non-excludable and have low rivalry of consumption (Benington 2007). No one can be effectively excluded from use of public goods and use by one individual cannot reduce availability to others.

The provisioning of public goods – from disease control to global market regulations – are essential so that food price volatility, global recessions and climate change can be jointly managed to minimise the global effects of localised shocks (Malik 2014). For example, malaria elimination is unquestionably a high-value global public good. When a country eliminates malaria, its neighbours are assisted in very definite ways, including elimination of importation of cases from the country that eliminated malaria. Cross border collaboration may result in benefits to the health sector and other sectors (Feachem et al 2010).

The provision of global public goods, including health, peace and a stable climate, can contribute to ending poverty by strengthening people’s resilience to economic, climate and other shocks.
Resilience in this context is understood to be an integrating concept that allows for multiple risks, shocks and stresses and how these impact both ecosystems and vulnerable people in a given timeframe (Mitchell & Harris 2012). The resilience of a system includes the capacity to anticipate and prepare for a shock or stress, the capacity to absorb, accommodate stress or destructive forces through resistance or adaptation, the capacity to manage, or maintain certain basic functions and structures, during disastrous events and finally, the capacity to recover or ‘bounce back’ after a shock or stress (Mitchell 2011).

Global public goods may provide opportunities such as freely and universally available information and technology. They may also ensure public participation and inclusion in the decision making process, building fairness into the international decision making architecture (Kaul 2013). While success should be celebrated, gains cannot be assumed to be permanent. Helping vulnerable groups and reducing inequality will be essential to sustaining development both now and across generations (Malik 2014).

Based on analysis of the available evidence, the 2014 report makes a number of important recommendations for achieving a world which addresses vulnerabilities and builds resilience to future shocks. The report describes basic social services as including education, health care, water supply and sanitation, and public safety. Universal provision of basic social services can raise social competences and reduce structural vulnerability. It can be a powerful force for equalizing opportunities and outcomes (UNDP 2014).

The 2014 Report calls for universal access to all basic social services with universal access to health care being an essential element of more-sustainable human development and improved resilience (UNDP 2014). This call to action for universal health care is complimented by the
GAP for the Prevention of Avoidable Blindness and Visual Impairment 2014-2019. The aim of the global action plan is to create a world in which nobody is needlessly visually impaired, where those with unavoidable vision loss can achieve their full potential, and where there is universal access to comprehensive eye care services (WHO 2013). There is more detail presented on Global Action Plan, universal health care and the political landscape affecting blindness and VI later in the thesis.

3.4 Mozambique and the health related MDGs

On a country level, progress towards achieving the health-related MDG targets has varied. Some countries have made impressive advances. Others have had less to celebrate. Countries with high levels of HIV, economic hardship or conflict have made the least progress towards the MDGs (WHO 2014 c).

Over half of the people who live in Mozambique live below the poverty line. Some progress has been made through poverty reduction strategies, but access to basic social services remains inadequate (WHO CCS 2014). Despite this, there here has been promising progress towards the health related MDGs. For example, neonatal mortality has dropped to 30 deaths/1000 and the under-five mortality rate to 90/1000. Other health outcomes remain unsatisfactory. Malaria accounts for about 26% of hospital deaths and HIV prevalence continues to be of concern. In addition, dual infections of TB and HIV, and the threat of increasing multi drug TB resistance, complicate the national TB program response. Women and children struggle to access essential services due to inadequate geographic coverage of health services, inadequate financing,
shortage of health professionals and essential medicines. This contributes to the high maternal and child mortality (WHO CCS 2014).

**Table 2 - Current health indicators for Mozambique (GHO 2014)**

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Population under 15 (2012)</td>
<td>45.38</td>
</tr>
<tr>
<td>% Population over 60 (2012)</td>
<td>5.01</td>
</tr>
<tr>
<td>Life expectancy at birth (2012)</td>
<td>53 (Both sexes)</td>
</tr>
<tr>
<td>Neonatal mortality rate per 1000 live births (2012)</td>
<td>30 [19-50] (Both sexes)</td>
</tr>
<tr>
<td>Under-5 mortality rate per 1000 live births (2012)</td>
<td>90 [77-106] (Both sexes)</td>
</tr>
<tr>
<td>Maternal mortality ratio per 100 000 live births (2010)</td>
<td>490 [300-850]</td>
</tr>
<tr>
<td>% DPT3 Immunisation coverage among 1-year olds (2012)</td>
<td>76</td>
</tr>
<tr>
<td>% Births attended by skilled health workers (2011)</td>
<td>54.3</td>
</tr>
<tr>
<td>Density of physicians per 1000 population (2008)</td>
<td>0.03</td>
</tr>
<tr>
<td>Density of nurses and midwives per 1000 population (2008)</td>
<td>0.34</td>
</tr>
<tr>
<td>Total expenditure on health as % of GDP (2011)</td>
<td>6.6</td>
</tr>
<tr>
<td>Total expenditure on health per capita (Intl $, 2012)</td>
<td>66</td>
</tr>
<tr>
<td>General government expenditure on health as % of total government expenditure (2011)</td>
<td>7.7</td>
</tr>
<tr>
<td>Private expenditure on health as % of total expenditure on health (2011)</td>
<td>58.3</td>
</tr>
<tr>
<td>Adult (15+) literacy rate total (2010)</td>
<td>56.1</td>
</tr>
<tr>
<td>Population using improved drinking-water sources (%) (2011)</td>
<td>33 (Rural)</td>
</tr>
<tr>
<td></td>
<td>78 (Urban)</td>
</tr>
<tr>
<td></td>
<td>47 (Total)</td>
</tr>
<tr>
<td>Poverty headcount ratio at $1.25 a day (PPP) (% of population) (2008)</td>
<td>59.6</td>
</tr>
</tbody>
</table>

The health system is poorly positioned to cope with chronic Non-Communicable Diseases (NCDs), neglected tropical diseases (NTDs), road traffic injuries and domestic violence. Natural disasters (in particular flooding), frequent outbreaks of cholera and the risk of newly emerging epidemic prone diseases require strengthened emergency preparedness and response, including stronger surveillance systems and implementation of the International Health Regulations (WHO CCS 2014).
Total health expenditure per capita describes the sum of public and private health expenditures as a ratio of total population. It covers the provision of health services (preventive and curative), family planning activities, nutrition activities, and emergency aid designated for health but does not include provision of water and sanitation. Data are in current U.S. dollars. Although Mozambique has increased its health expenditure per capita in recent years, it still lags behind other countries – even those in Sub-Saharan Africa (World Bank 2014 b).

Figure 10 - Health expenditure per capita (current US$) in Mozambique compared to Sub-Saharan Africa (developing countries only) (World Bank 2014 b).

A comparison of total health expenditure as a percentage of GDP shows Mozambique to be similar to the developing countries in Sub-Saharan Africa. It is still below the percentage of GDP
spent on health in industrialised nations. Data from the Euro Zone countries is displayed in Figure 11, by way of example.

Figure 11 – Total health expenditure (% of GDP) in Mozambique, Sub-Saharan Africa (developing countries only), and countries in the Euro Zone (World Bank 2014b).

In Mozambique, a new Health Sector Strategic Plan 2014-2019 recognises that investment in health systems structures and functions is needed (WHO CCS 2014). It set out seven strategic objectives and is based on principles of primary health care, equity and better quality of services:

- Increase access and utilisation of health services.
- Improve quality of service provision.
• Reduce geographic inequities and between different population groups in accessing and utilising health services.
• Improve efficiency on service provision and resource utilisation;
• Strengthening partnerships for health.
• Increase transparency and accountability on management of public goods.
• Strengthen the health system

The health system is composed of public, private for profit and non-profit private sector. The public sector is the main provider, covering about 60% of the population. To increase coverage and access to services Mozambique needs a stronger primary health care service and improved quality of care. It also needs to scale up the health workforce and expand the health facility network (WHO CCS 2014).

Primary eye care is an important aspect of primary health care. Like all other aspects, it can defined as a frontline activity, providing care and identifying disease before it becomes a serious medical issue. Primary eye care can be delivered in many different ways. Components of primary eye care include eye health education, symptom identification, VA measurement, basic eye examination, diagnosis and timely referral. Primary eye care cannot be considered as a stand-alone activity but should be integrated into existing primary health care systems. The roles and responsibilities of primary eye health providers around the world may vary with the context of the communities they work in. Primary eye health should cover the basics of primary health care namely sanitation, nutrition, immunisation, and hygiene (Murthy & Raman 2009).
3.5 Blindness and VI in Mozambique

There is a paucity of prevalence data for causes of blindness and VI in Mozambique. Despite the lack of published evidence, the National Eye Health Plan (2007 – 2010) estimated that approximately 720,000 people were either blind or had severe VI, with an estimated 180,000 of these being already blind (MISAU 2007). The plan states that the leading cause of blindness in Mozambique is cataract, which alone is responsible of some 100,000 cases. The plan states that severe VI is mainly caused by mainly due to glaucoma, trachoma and URE (MISAU 2007).

In recent years, prevalence data has improved in Mozambique, mainly due to the completion of two Rapid Assessments of Avoidable Blindness (RAABs) and one Rapid Assessment of Refractive Error (RARE) studies. RAABs and RAREs are relatively simple, cheap and rapid survey methodologies. RAABs provide data on the prevalence and causes of blindness, cataract surgical outcome and coverage as well as on the main barriers to uptake of cataract surgery. They only include people who are 50 years old or older. Prevalence of blindness is known to be higher for this demographic group, so smaller sample sizes are required (Bedri 2014). RARE studies aim to determine the prevalence of URE and presbyopia, to assess spectacle coverage and to investigate the vision related quality of life. It involves gathering data on all persons between 15 and 50 years of age (Loughman et al 2014).

The RAAB in Nampula found that the prevalence of blindness was 6.3% and that the prevalence of VI was 8.6% (Kimani 2011). URE was found to be the leading cause of moderate VI and second leading cause of severe VI, accounting for 43.5% and 15.6% of cases respectively, in people over 50 years old (Kimani 2011). The study found that 80% of cases of blindness and VI observed were deemed to be avoidable (Kimani 2011).
The RAAB in Sofala Province found that the prevalence of blindness was 3.2% and that the prevalence of VI was 17.5% (Bedri 2014). Cataract was responsible for 54.2% of blindness and 48% of VI (Bedri 2014). Avoidable causes of blindness were responsible for 73% of bilateral blindness and 90% of bilateral VI (Bedri 2014). Cataract surgical coverage indicated that only 33.1% of those with bilateral cataract who needed surgery had had surgery at VA <3/60 (Bedri 2014). The barriers to accessing cataract services included lack of awareness that treatment is possible or where to get the services, false belief that cataract blindness is normal for old age, services not being available or distant from where the patients live, nobody accompanying the patient to go for surgery and fear of surgery (Bedri 2014).

The RARE in Nampula Province found the prevalence of vision impairment was 3.5% (95% CI 4.9 2.7% - 4.2%), with 65.8% of those with VI being 35 years of age and older. URE prevalence was 2.6% (95% CI 2.1%-3.2%), and was the primary cause of vision impairment among 64.5% of cases (Loughman et al 2014). The spectacle coverage for URE was 0%. Presbyopia prevalence was higher, at 25.8% (95% CI 12.0% - 30.5%), with only 2.2% spectacle coverage (Loughman et al 2014). By comparison, a RARE study completed in Eritrea found URE prevalence was 6.4% (95% CI 5.6%-7.2%) and spectacle coverage of 22.2%, while for presbyopia, prevalence was 32.9% (95% CI 30.3%-35.7%) with spectacle coverage of 9.9% (Chan et al 2013). This comparison indicates how poorly developed and inaccessible refractive error services are in Mozambique compared to Eritrea.
3.6 The education system in Mozambique - An overview

Years of conflict in Mozambique left the education system dysfunctional. During the war years, enrolment plummeted. Gross enrolment in primary school was at only 50% and net enrolment below 40% (Fox et al 2012). Infrastructure was damaged or destroyed, and schools were completely absent in many rural areas. Since the end of the civil war, the objective of Government policy has been to provide quality education for all with a focus on primary education (Fox et al 2012).

In Mozambique the basic education cycle comprises two primary levels: lower and upper primary. Once a student has completed upper primary, they can enter secondary school. There are various technical and vocational education and training opportunities for graduates of lower and upper primary, or lower secondary. Students who complete secondary school can enter tertiary or university education (Fox et al 2012).

The levels of education in Mozambique and grade requirements for entry are as follows:

- **Primary education with intended entry at age 6**
  - EP2 (Ensino Primário do 2º Grau): grades 6–7 (ages 11–12)

- **Secondary education**
  - ES1 (Ensino Secundário do 1º Ciclo): grades 8–10 (ages 13–15)
  - ES2 (Ensino Secundário do 2º Ciclo): grades 11–12 (ages 16–17)

- **Technical and vocational education and training**
  - Elementary (grade 5 required, 2–3-year programs)
  - Basic (grade 7 required, 3-year program, equivalent to grade 10 upon completion)
- Medium (grade 10 required, 2-year program, equivalent to grade 12 upon completion)

- **Teacher education**
  - Basic (grade 7 required, 3-year program)
  - Middle (grade 10 required, 1-year program)

- **Tertiary education (university)**
  - Grade 12 required

Mozambique also has an adult literacy program. The education system includes both public and private schools. The vast majority (95%) of primary students attend public schools. The private sector is particularly important for the upper secondary level (ES2). Approximately 30% of students attend private secondary schools (Fox et al 2012).

Despite improvements in education, much remains to be done. Teacher quality is low due to inadequate training. Many teachers work double or triple shifts to cope with the shortage of classrooms and teachers. In the lower primary level, there is an average of one teacher for every 74 children (UNICEF 2014). The completion rate, which is a key indicator for measuring the quality of education, remains low – nearly half of primary school aged children leave school before they complete grade five. Many schools have poor water and sanitation facilities. There is a shortage of desks and materials (UNICEF 2014).

The impact of poverty, and specifically the burden of HIV/AIDS, has placed additional pressure on the education system. Schools have to take on many of the functions that families traditionally performed in relation to children’s education and care, such as providing health services and psycho-social assistance to orphaned and vulnerable children. Children living in the poorest
families, orphans and girls are especially at risk of dropping out of school or not going to school at all (UNICEF 2014).

Since 2000, the Government has allocated an average of 20% of revenue, about 5% GDP, to the education sector (Fox et al 2012). Between 2000 and 2003, the number of schools increased significantly, with the addition of 1,005 lower primary schools and 428 upper primary schools. This supply expansion was met with overwhelming demand. However, the improvement in enrolment did not improve education for Mozambique’s most vulnerable children. Girls and children in rural areas were still not going to school. Also, although physical access improved, efficiency did not. Retention and completion rates were low (Fox et al 2012).

In 2003, only 40% of school-age children completed lower primary school and 17% completed upper primary school (Valerio et al 2006). Mozambique differs from many African countries, as entrance into successively higher levels of schooling is based on a student’s grades and age, rather than on national examinations. If the situation arises where two students have equal grades, the younger student is given priority (Handa et al 2004).

Wide inequality remains a challenge between population groups in lower secondary completion. The most vulnerable members of society are yet to benefit from progress. In Mozambique almost no young women from the poorest families completed lower secondary school in 2010/2011. Also, while the number of years of schooling among the richest urban young men increased by 3.5 years, to 9.6 years, among the poorest rural young women it only increased by less than a year, to 1.9 years (UNESCO 2014).

Policy recommendations from an International Food Policy Research Institute report suggest that investing in female education in rural areas will have very large monetary and non-monetary
benefits in Mozambique. Interventions that increase female adult literacy and that stimulate school enrolment of girls in rural areas should be a priority. The benefits will be felt by both individuals and society (Handa et al 2004).

Other recommendations include pursuing policies that alleviate the monetary constraint of households will have an important impact on school enrolment. Such policies include school lunches, as well as reduced fees for tuition, books, and uniforms. In urban areas, research has indicated that primary school dropout rates increase significantly at around age 10. Policies should focus on keeping children of this age in school. School enrolment will be improved through better quality schools that are more efficient and easier to access. Schools with a higher ratio of trained female teachers tend to have a better pass rate for girls (Handa et al 2004).

Fox et al (2012) describe how with support from donors and key stakeholders, the Government in 2004–05 moved to address the causes of low enrolment by enacting an important set of reforms as follows:

1. Reduction in direct costs for households and provision of free textbooks.
2. Increased funding at the school level.
3. New curriculum.
4. Semiautomatic promotion

Also, positive government action has seen the numbers of female teachers in grades 1 to 5 almost tripling between 1998 and 2008 and increasing sixfold in grades 6 and 7. The Heads of teacher training colleges are actively encouraged by the Ministry of Education to take measures aimed at recruiting more women, including allocating more places for female students. The proportion of women students in these colleges as a result has consistently been at or above 50%. Such
affirmative measures have helped increase the number of women teachers quickly (UNESCO 2014).

Although challenges remain, on the whole the primary and secondary education system in Mozambique has improved dramatically. The United Nations Children's Fund (UNICEF) report that 100% of the Mozambican children are enrolled in primary school. This figure was 69% in 2003. The education system has been slowly improving since the mid-1990s (UNICEF 2014).

### 3.7 Higher education in Mozambique

In 1962 the first higher education institution was created, called Estudos Gerais Universitários. This was upgraded to the University of Lourenço Marques in 1968. Until 1974, Mozambican students constituted less than 0.1% of the student population, with the majority of places taken by the children of Portuguese settlers (Chilundo 2010).

A year after independence, it was transformed in to the Eduardo Mondlane University in 1976. The mission shifted to deliver highly trained staff that Mozambique needed to solidify the independence of the new Republic. UEM became the first truly Mozambican university. It remains the major university in the country (Bailey et al 2011).

Today there are 26 higher education institutions, of which 13 are public and 13 are private. The number of private institutions has been growing rapidly since their introduction in 1995. The institutions are of three types: universities, polytechnics and tertiary schools. In 2006, UEM had 61% of student enrolments among the public higher education institutions in the country (41% of all student enrolments, public and private). With close to 12,000 enrolled students, the institution
had more than double the students of the second largest institution in the country (Universidade Pedagogica), which in turn was much larger than the rest (Bailey et al 2011).

All private higher education institutions together enrolled, in 2005, a third of all higher education students. The geographic expansion of higher education has also been rapid, either through the establishment of satellite campuses or the opening of new universities in the provinces. Despite the rapid growth of university places, students in higher education institutions represent a very small segment in relation to the population as a whole. Only 0.16% or 40 in every 100,000 inhabitants of the age cohort 20–25 study at a higher education institution (Chilundo 2010). By way of comparison, in Zimbabwe and Botswana there are 638 and 596 university students respectively for every 100,000 inhabitants (Chilundo 2010).

The number of full-time academic staff is about 1,200, of which 15% have PhDs, 25% have masters, and 60% are holders of a first degree (bachelors or licentiate). These numbers indicate that there is still a need for high investment in staff training at the masters and PhD levels (Bailey et al 2011).

In Mozambique, 40% of the education budget is devoted to higher education, which is relatively high. A feature of the system is the high level of dependence on donor funding. There is minimal cost sharing in the system and government funds institutions on the basis of inputs (student numbers) only. The pattern of funding suggests a high degree of inefficiency and inequity. Innovative features of the system include the funding of quality improvement initiatives in both public and private higher education institutions, and provincial (rural) scholarships to address equity (Pillay 2010).
In 1999, government expenditure on higher education constituted about 0.8% of the GNP, with public expenditure of about US$ 1,700 per student. Students in the public system pay a low tuition fee (around US$ 100 per annum). State budget allocations to higher education increased by more than US$ 6 million per annum, having jumped from US$ 29 to US$ 40 million between 2004 and 2006. The respective amounts have systematically represented around 2% of the state budget. The majority of funds have been spent on building infrastructure, developing human capacity and installing information and technology infrastructure (Chilundo 2010).

The institution of Universidade Lúrio, which is the focus of much of the research presented in this thesis, was created in 2006. An opening ceremony was held on 29 June 2006, chaired by His Excellency the President of the Republic of Mozambique, Armando Guebuza and the Education Minister, Aires Aly. Its first college, the Faculty of Health Sciences, the rectory and central services were established in 2007. The mission of Universidade Lúrio is to provide a high quality of tertiary education to the underserved three northern provinces of Mozambique, namely: Nampula, Niassa and Cabo Delgado (UniLurio 2014).

3.8 Conclusion

This chapter presented an introduction to Mozambique, including a brief history of Mozambique, and its current status regarding health, education, and development. It introduces the whole education system in Mozambique before focusing on the tertiary education system. Although there is a paucity of epidemiological data for Mozambique regarding blindness and VI, the data that does exist was presented.
Chapter 4. Human Resources for Health and the Mozambique Eyecare Project

4.1 Introduction

This chapter provides details of the MEP. A regional overview of optometry and higher education is given. Universidade Lúrio is one of 17 universities in Africa to currently offer optometry courses. The wider roll in the community that an institute offering optometry education offers is discussed, as are some of the challenges faced by the universities while educating students and reducing the burden of blindness and VI. A significant problem, which Universidade Lúrio and other institutions in Lusophone Africa experience, is language. Academia is dominated by English, yet in Mozambique, Portuguese is the official language. This, combined with how optometry as a discipline is not traditionally strong in Portuguese speaking countries, presented challenges to the optometry course and the MEP. This chapter serves to provide background information on the education system, Universidade Lúrio and the Mozambique Eyecare Project.

4.2 Mozambique Eyecare Project

The MEP was a partnership that facilitated the development, implementation and evaluation of a regional optometry model for Lusophone Africa. The project led to a partnership developing between Universidade Lúrio and Dublin Institute of Technology (DIT) in the Republic of Ireland, University of Ulster in Northern Ireland, Brien Holden Vision Institute in South Africa. The goal of the MEP was to reduce incidences of avoidable blindness and VI in Mozambique caused by refractive errors by the year 2020. One of the major outputs from the MEP was the development of a regional College of Optometry, situated at Universidade Lúrio’s Faculty of
Health Science in Nampula City, the principal city of Nampula Province. The new college now acts as a centre for undergraduate optometric education and postgraduate research. It allows greater access to training for eye health professionals, leading to improved capacity to address avoidable blindness and VI. The optometrists trained at Universidade Lúrio will work towards the goal of providing affordable and accessible eye health within the public system (MEP 2014).

Figure 12 – A student from DIT working with a student from Universidade Lúrio

In the MEPs early stages, the plan was to offer a two tier training system. A mid-level qualification would be offered after two years of study, with the option to upskill in the future to a degree level optometrist. However, after lengthy consultation with the Ministry of Health, Ministry of Education and Universidade Lúrio, it became clear that the mid-level training did not fit the existing system in Mozambique. The project plan was amended to focus on the degree level qualification and supporting the training of an existing cadre of ophthalmic technicians, who were found to be in need of further training. Research has indicated that upskilling the ophthalmic technicians is effective in improving confidence and competence levels for refraction
(Shah et al 2014). The MEP supported both the upskilling of the existing ophthalmic technicians as well as educating the optometry students to degree level. The first graduates from the College of Optometry at Universidade Lúrio graduated in 2013. Their names were:

- Joel L De Melo Bambamba
- Angela J Efecio
- Antonio M Ramos
- Hermengildo BJF Tomo
- Sergio M Uageito
- Nordino J Mboto
- Janet E Abudo Abduale
- Cerena F Caetano Figueiredo
- Neusa B Mario da Cruz Namruette

They are the first optometrists in to qualify not only in Mozambique, but also in Lusophone Africa. Their graduation day is illustrated in Figure 13. Joel De Melo Bambamba was absent.

Another key output from the MEP was postgraduate research, designed to evaluate, assess and explore key questions regarding eye health and human resourcing in Mozambique. The postgraduate research team is made up of five researchers from both the global north and the south. This current thesis forms part of that research. Ethical approval was granted for the study under the MEP by DIT’s ethics committee. Further ethical approval in Mozambique was sought. Ethics approval was granted for the WTP study and the barriers study by the National Ethics Committee of Mozambique (Comité Nacional de Bioética para Saúde). The research followed the tenets of the Declaration of Helsinki.
Figure 13 – The first optometry graduates

4.3 Optometry and higher level education

A systematic review on higher education has reported that the available evidence suggests that tertiary education has a stronger impact on economic growth than was previously assumed – the data suggests that it has a stronger impact than lower levels of education do (Oketch et al 2014). However, it should be noted that certain conditions are needed for students to enter and complete tertiary education. This may include improved health, literacy, access to high-quality primary and secondary education, civic participation, good governance and the protection of human
rights. While there is ongoing discussions around the most effective way to fund and develop education, it is clear that the different education levels are interconnected - mainly that development of lower stages benefits higher stages. For example, primary enrolment rates and expenditures per pupil would impact on secondary enrolment rates, which in turn will impact on college enrolment rates (Keller 2006).

There is a danger in investing in one or two levels of education at the expense of the others. If investment in tertiary education comes at the expense of other levels of education, negative results are likely to be returned (Oketch et al 2014). Research in East Asia has shown that high levels of primary and secondary enrolment were needed for increased enrolment in tertiary education to impact growth (McMahon 1998).

Tertiary education has a positive impact on wages of graduates and productivity in the workplace. Tertiary education is also shown to assist graduates with a range of benefits relating to improved health, strengthened gender equality and democracy. Communities where tertiary education facilities are based also stand to benefit through the provision of services and use of facilities and buildings (Oketch et al 2014). The teaching clinic at Universidade Lúrio is regularly open to the public, with students giving eye examinations while under supervision.

In addition to teaching clinics, all students enrolled at Universidade Lúrio (including the optometry students) are required to participate in the One Student One Family programme. The objective of the initiative is to educate and train a new generation of professionals, who are competent and committed to development, science and the welfare of local communities (UniLurio 2014). This initiative aims to improve the public health of disadvantaged communities in Nampula province through information dissemination and increased interaction between health science students and the general public. It also provides the students with the opportunity
to interact with the community and apply their theoretical knowledge in the local context. This experience will enhance their patient care and as it is a community informed project, it ensures the wider eye health programme follows a pro-poor approach. The programme is designed to benefit all parties involved, fostering a four way relationship. The relationship is displayed in Figure 14 and the benefits of the programme are displayed in Table 3.

Figure 14 – The four way relationship fostered by the One Student One Family programme (Thompson et al 2011)
Table 3 – The benefits of the One Student One Family programme (Thompson et al 2011)

| Benefits to the Students | • Improved clinical practice  
|                          | • Broader awareness of health science  
|                          | • Introduction to scientific research  
|                          | • Problem solving  
|                          | • Interaction with other students  
|                          | • Sense of belonging to Nampula  
| Benefits to the families | • Increased awareness of general public health  
|                          | • Improved hygiene  
|                          | • New way to access to knowledge  
|                          | • Increased trust in modern medicine  
|                          | • Increased disease prevention  
|                          | • The importance of education is disseminated  
| Benefits to the Community | • Improved community public health  
|                          | • Direct access to (future) health care professionals  
|                          | • Community access to University facilities  
|                          | • Ripple effect (benefits spread throughout the community, including those who are not participating in the initiative)  
|                          | • Reduced pressure on local health facilities  
|                          | • Communal areas improved  
| Benefits to the University | • The community develops an understanding of the institution  
|                          | • As a public institution, the university can demonstrate a return on investment and value for money  
|                          | • Improved research  
|                          | • Strengthen learning outcomes  

The One Student One Family first involves a process of consultation with community leaders. Each student is put with students from different courses to form a group. The student groups offer peer support to each other. Each student is also assigned their ‘family’ from the local community. The student and the family remain linked throughout the student’s university course. The student becomes a point of contact for the family. The student offers advice on health and nutrition. In most cases, the family welcomes the student in like one of their own children. This forms an important link to the local community, particularly for students who are not originally from Nampula. For the theoretical part of the programme, students from semesters 1 to 4 focus on basic public health. From semester 5 onwards the students focus on discipline specific public health. Each week, students are required to dedicate two hours to learning the theory and two hours in the community. Once a relationship is formed, most students spend more time than the allotted two hours with their families. Some are invited to attend family celebrations. Others may accompany family members to the doctors if they are requested to do so (UniLurio 2014).

Figure 15 – The interactions between a typical One Student One Family group and their assigned families from the local community (Thompson et al 2011)
The One Student One Family programme addresses a current deficit in eye health knowledge within the local community by transferring knowledge from optometry students to the general public. Innovative models of education and interaction between students and the community may be necessary to address the eye care needs of the country, the region and the continent.

Figure 16 – An optometry student with his assigned ‘family’

A study into the sustainability of eye health programmes in Ghana found that facility-based interventions were more likely to be successful and sustained after initial funding had ended. Facility based services (as opposed to field based services) were found to be more likely to be routinised and sustained in the longer term (Blanchet & James 2014).
Universidade Lúrio is one of 17 established institutions offering optometry degree programmes in Africa. It is recognised that other cadres are working to reduce the burden of blindness and VI, including addressing URE. However, the significant unmet need suggests that further optometry institutions need to be established in the region. There is also a need to place greater emphasis on postgraduate education to meet the institutional, national, and international professional training standards and to ensure sustainability of optometry education (Oduntan et al 2014). At institutions where a degree course is now established, the next stage is to develop systems that encourage and foster research. To maximise societal benefits, research capacity at tertiary level institutions must be improved (Oketch et al 2014).

![Figure 17 – An optometrist testing school children](image)

Universidade Lúrio is a Portuguese speaking institution and a member of the Association of Portuguese Language Universities, known as AULP. AULP has 140 members from seven Portuguese-speaking countries (Portugal, Brazil, Angola, Mozambique, Guinea-Bissau, Sao
Tome and Principe) and Macau. As an association, its objective is to facilitate communication between members in favour of collective development and teaching of the Portuguese language in the world. It encourage research and the exchange of students and teachers (AULP 2014).

Although Portuguese is the official language of Mozambique, the majority of the population speak a local indigenous language (a Bantu language) or dialect first, then they learn Portuguese when they go to school. For most students in Mozambique, English is a foreign language. It may be their third or even fourth language (Cabinda 2013). A challenge faced by Universidade Lúrio and all Portuguese speaking institutions is the dominance of English in higher education and academia. This dominance is placing huge pressures on non-English speaking institutes both in terms of teaching and research. By the beginning of the 21st century, English was the medium of most scientific publications (Lillis and Curry 2010). Most academic journals and scientific websites use English and many universities encourage or even demand that their professors publish in English-medium journals as evidence of quality scholarship. English is seen by some people as being destructive of academia in other languages, as other languages are brushed aside in favour of publishing in English (Cabinda 2013). For authors whose first language is not English, acceptance of their work by these influential publications is notably more difficult. It is also a challenge for undergraduates, as most of the literature they require to study is in English (Altbach & Salmi 2011).

It is a challenge for Universidade Lúrio and other higher education institutions in the global south to provide access to up-to-date and relevant academic literature. In an age where more research is being published than ever before the students and staff must be provided with the most relevant and recent scientific information, in order to teach, study and conduct research. The time lag between when something is printed and when it is available to students in
Mozambique may compromise their education. In addition, conducting comprehensive research using paper systems is time-consuming and can prove to be a science in itself (Ferrão & Thompson 2012).

‘eLearning’ has been shown to provide an opportunity to overcome some of these challenges and to level the global academic playing field. It presents us with a reality where a relatively young university in Northern Mozambique can offer students the same access to the most recent and relevant journal articles as a well-established institution in England with centuries of history in research (Ferrão & Thompson 2012).

Some action has been taken to try and overcome the challenges faced by researchers whose first language is Portuguese. For example, the ePORTUGUÊSe network, developed by the WHO, supports the development of human resources for health in Portuguese-speaking Member States by facilitating collaboration among institutions, delivering health information, and promoting capacity building. One of the main objectives is to improve access to health-related information in Portuguese through development of a virtual health library (WHO 2014b).

Also, Universidade Lúrio’s Faculty of Health Science, is a member of the HINARI Access to Research in Health Programme Network. This Internet-based programme was developed by the WHO, together with major publishers to provide health science students, teachers and researchers in countries such as Mozambique, with the access to the literature they require. The portal provides access to more than 8,500 journals and 7,000 e-books in 30 different languages, all of which can be downloaded for free (HIRANI 2014). A journal article, published in New York, can be downloaded on the same day that it is made available by a student from any one of these courses, without having to pay a fee. The Internet reduces the barriers of time and cost, which previously restricted students and staff from progressing.
Although technology is revolutionising the way in which universities operate, it does not come without its challenges. Universidade Lúrio and the other tertiary education institutions must upgrade their information communication technology systems, to make the most of what this new age of Internet-based academia has to offer. This includes faster Internet connections, more computer facilities on campus and the professional expertise to optimise the use of ICT systems (Ferrão & Thompson 2012).

4.4 Conclusion

This chapter builds on the information that was presented in the previous chapters to give further background information which is needed prior to the analytical chapters. It gives details of the purpose of the MEP and how it was delivered. A regional overview of optometry and higher education is given to contextualise the developments in Mozambique. Although the main two purposes of higher education institutions is to provide education and complete research, universities deliver other benefits, including support to the community. This is particularly pertinent with optometry departments, as the clinics are often open to the public – benefiting both the local communities and the students who need to practice in a controlled environment.

This chapter provided background information specific to both Universidade Lúrio and the MEP. The information in this chapter, combined with the information in the previous introductory chapters, provides the foundation upon which the analytical chapters can be built, and explains the context which they should be understood.
Chapter 5. The development of a public optometry system in Mozambique: a Cost Benefit Analysis

5.1 Introduction

Refractive error occurs when the eye cannot clearly focus incident light on the retina, resulting in blurred vision. It refers principally to the conditions of myopia, hyperopia, and astigmatism, while presbyopia represents a related, and age dependent, inability to focus clearly on near objects. URE is the leading global cause of low vision, and causes almost half of all VI (Resnikoff et al 2008). It is recognised as a priority public health condition by a joint programme of the WHO and the IAPB under the global initiative, VISION 2020 (IAPB 2014 a). Addressing URE is a priority, not just because of the burden of blindness and VI that it is responsible for, but also because of how easily and affordably it can be treated (Holden & Resnikoff 2002). URE hampers education, limits employment opportunities, reduces productivity, and has been shown to impair quality of life (Resnikoff et al 2008, Holden & Resnikoff 2002). Simple and effective eye health interventions including an eye exam and provision of suitable spectacles can address the burden of URE (Dandona & Dandona 2001 b).

In Mozambique, the burden of URE is thought to be high, having a severe impact on the livelihoods and wellbeing of disadvantaged communities (MISAU 2007). A RARE study in Mozambique found the prevalence of vision impairment was 3.5% (95% CI 49 2.7% - 4.2%), with 65.8% of those with VI being 35 years of age and older. URE prevalence was 2.6% (95% CI 2.1%-3.2%), and was the primary cause of vision impairment among 64.5% of cases. The spectacle coverage for URE was 0%. Presbyopia prevalence was higher, at 25.8% (95% CI 12.0% - 30.5%), with only 2.2% spectacle coverage (Loughman et al 2014). By comparison, a
RARE study completed in Eritrea found URE prevalence was 6.4% (95% CI 5.6%-7.2%) and spectacle coverage of 22.2%, while for presbyopia prevalence was 32.9% (95% CI 30.3%-35.7%) with spectacle coverage of 9.9% (Chan et al 2013). This comparison indicates how poorly developed and inaccessible refractive error services are in Mozambique compared to Eritrea.

The MEP facilitated the development, implementation and evaluation of the first and only optometry programme in Mozambique. It included the establishment of a four-year BSc optometry course at Universidade Lúrio, a public university, in Nampula. Graduates are expected to work in the public health system once qualified. It is expected that these graduates will make a significant impact on eye health in general but specifically on the provision of refractive services. This should address a major need as outlined in the paragraph above. The recently founded programme presented a unique opportunity for a CBA to determine whether investing in optometry is economically justifiable.

Economic analysis is used to inform health planners and policy makers how limited resources should be allocated, indicating which interventions are good value for money. It can assist with justifying decisions on different resource allocation pathways (Smith & Brown 2000). CBA compares the resources spent on an intervention to the benefits gained or resources saved as a result of the intervention. It is useful for demonstrating savings associated with healthcare policy decisions, and can be used to gauge the desirability of an intervention in terms of its economic worth to society (Brown & Brown 2005, Sinden & Thampapillai 1995).
5.2 Methods

Ethical approval was granted for the study under the MEP by DIT’s ethics committee. A standard CBA methodology was applied across the period 2009-2049. All costs were converted into United States Dollars ($). Costs for the first four years were based on actual figures, gathered using multiple resources including MEP financial reports, current market price information, and national human resources data. Future costs (those incurred after 2013) were assumed. They were projected based on a model developed using existing data. They included all costs associated with the establishment of an optometry degree programme, the establishment of vision centres within public hospitals, human resources costs, and overheads. The initial costs incurred during the implementation period were met by the MEP partners. Future costs may be met by the MEP partners, a range of funders, organisations interested to be involved in the partnership, and national government. The benefits associated with students enrolling in the last four years of the analysis period were omitted, although the costs associated with their education were included to reflect the on-going nature of the programme. Costs were subtracted from benefits to provide the net societal benefit, which was discounted to provide the net present value (NPV) using a 3% discount rate to factor in the time value of money (Frick & Foster 2003, Frick et al 2005). Costs and benefits from years 2 through to 41 were discounted to the present value at the start of the program in 2009.

Benefits were calculated using a human capital approach to valuing sight, measuring the potential economic productivity foregone by not addressing URE. Potential productivity gained by addressing URE was estimated using the value of $1,200 as GDP adjusted for PPP per capita as a proxy indicator (CIA 2014). It was assumed that optometrists would work 242 days per annum, on average correcting the URE of 15 patients who are potentially economically
productive per day (conservatively based on existing hospital clinic sessions staffed by ophthalmic technicians who examine 30-40 patients per day). A LFPR of 82.75% and an ER of 79% were included to reflect the labour market and the fact that the emergence of productivity is not a certainty (CIA 2014, UN 2014).

The potential impact of VI on productivity was calculated by applying DWs, used to quantify the severity of a disease or condition through a scale where 0 represents perfect health, 1 represents death, and every point in between reflects a level of disability associated with the specific disease or health condition, to PPP-adjusted GDP per capita. DWs for VI detailed in the 2010 GBD study were incorporated into the analysis (Salomon et al 2012). The original GBD study detailed a single DW for all categories of VI (Frick & Foster 2003). For the revised study, VI was divided into four categories, with each category assigned lower DWs than the original DW, as displayed in Table 4 (Bourne et al 2013).

**Table 4 – VI category definition by visual acuity* in the better eye and associated new DWs**

<table>
<thead>
<tr>
<th>VI category</th>
<th>Definition</th>
<th>DW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance mild VI</td>
<td>&lt;6/12 but ≥6/18</td>
<td>0.004</td>
</tr>
<tr>
<td>Distance moderate VI</td>
<td>&lt;6/18 but ≥6/60</td>
<td>0.033</td>
</tr>
<tr>
<td>Distance severe VI</td>
<td>&lt;6/60 but ≥3/60</td>
<td>0.191</td>
</tr>
<tr>
<td>Near VI</td>
<td>&lt;6/12 but ≥3/60 for near, but ≥6/12 for distance</td>
<td>0.013</td>
</tr>
</tbody>
</table>

*Snellen VA or the equivalent calculated from published LogMAR values.

Prevalence data of VI from previous studies informed distribution across the categories (Holden et al 2008). Due to limited data distinguishing between mild and moderate VI, these two categories combined into one and an average DW of 0.0185 assigned. To keep the analysis
conservative, only the revised DWs for VI were used and the productivity loss associated with blindness (VA < 3/60) was not included in the current study. Although the new DWs were used for the main body of this study, the original DW were included as part of the sensitivity analysis.

Spectacles were assumed to provide an effective solution to URE for up to four years once dispensed, based on studies in Africa, Asia, America and Europe (Vitale et al 2006, Baltussen et al 2009). The longevity of the spectacles in these studies is based on an assumption. Research is needed to establish how long spectacles can actually be expected to last for. Further investigation would also be useful to indicate whether this assumption is suitable specifically in the Mozambican context. To take into account prescription instability and spectacle frame/lens durability, effectiveness was assumed to be 100% in years one and two, 75% in year three and 50% in year four. After the fourth year the patient would return to suffering fully restricted productivity through URE and would need to return to the optometrist. The net benefit or loss was calculated by subtracting costs from benefits.

The population growth rate was assumed to stay constant at 2.3% per annum (World Bank 2014a). Seven students from the pilot group were assumed to enter the public system after graduation, with 15 expected to enter every subsequent year. The analysis period of 2009 to 2049 was defined by the time it would take, at such graduation rates, to reach a ratio of approximately one optometrist per 100,000 people, as shown in Table 5. This ratio represents half of the VISION 2020 target of one optometrist per 50,000 people (VISION 2020 2006). Student numbers are already higher than those in this analysis but conservative graduation rates were selected to take into account death, career change, and decision not to work in the public sector.
Table 5 – Predicted population trends and number of optometrist graduates over time

<table>
<thead>
<tr>
<th>Year</th>
<th>2019</th>
<th>2029</th>
<th>2039</th>
<th>2049</th>
</tr>
</thead>
<tbody>
<tr>
<td>Predicted population (million)*</td>
<td>28.7</td>
<td>36</td>
<td>45.2</td>
<td>56.8</td>
</tr>
<tr>
<td>Cumulative number of graduates</td>
<td>97</td>
<td>247</td>
<td>397</td>
<td>547</td>
</tr>
<tr>
<td>Optometrists per head of population</td>
<td>296,023</td>
<td>145,934</td>
<td>113,977</td>
<td>103,843</td>
</tr>
</tbody>
</table>

5.3 Results

The following costs were included.

Expatriate lecturers

Expatriate lecturers were employed to teach until local human resources become available to take over. It was assumed 25 teaching years would be needed to reach this position. A staggered transition from expatriate to local faculty was assumed in order to ensure minimum impact to the students’ educational experience. The cost of $45,000 per annum per expatriate lecturer, based on actual incurred MEP costs, was included.

Mozambican lecturers

The first optometrists graduated in 2013, but those selected to teach will need additional pedagogic training before they are ready to be educators. The first Mozambican optometrist lecturers were scheduled to be employed in 2015, working alongside expatriate lecturers during a transition period. By 2017 all lecturers were assumed to be Mozambican, at a cost of $18,514 per annum per lecturer.
**Management costs**

 MEP Management costs included advocacy, project and financial management, procurement, research and human resource development. Costs were $1.7 million over the first six years, to reflect the assigned Programme for Strategic Cooperation funding from Irish Aid and the project partners. A rate of $100,000 per annum was applied thereafter, to reflect on-going support from the partners, which will depend on securing new funding once the original funding phase has ended.

**School equipment costs**

In the first four years $330,000 was spent on the purchase and maintenance of equipment, with a rolling cost of $50,000 per annum applied thereafter.

**Educational material costs**

During the first four years, the actual cost of developing and translating educational materials was $126,000, with $5,000 per annum every year thereafter.

**Book/academic literature costs**

The cost of $3,000 per annum was assigned for books and academic literature.

**Faculty operating costs**

To reflect the general cost of running the university, $800 per student per annum was included, based on an estimate by the administration department at the university.

**Vision Centre equipment costs**

Once graduated, it was assumed that optometrists would work in Vision Centres, installed in existing public health facilities. A Vision Centre, designed to support two optometrists was calculated to cost $45,250. Costs included equipment, refurbishment/renovations, transport
including shipping and customs, management time, support costs, monitoring and evaluation and project management costs.

**Vision Centre human resource costs (Optometrists)**

The public sector salary of an optometrist with less than three years of experience was confirmed as $9,528 per annum, increasing to $9,912 per annum after three years of service.

**Vision centre human resources (Technicians)**

Each location was also assumed to require a technician to support the clinics, maintain equipment, and to assist with the manufacturing of spectacles bespoke to each patient. The salary of $3,503 per employee per annum was included.

**Vision centre human resources (Administrators)**

Each location was also assumed to require one administrator, who would receive the salary of $3,503 per annum.

**Vision Centre Overheads**

For use of electricity, water, and basic upkeep of the building, $672 per optometrist per annum was included. Significant building repair have not been included in this analysis.

Between 2009 and 2049, after applying a 3% discount rate the NPV of the cost of training and employing optometrists was $83.9 million, as shown in Table 6. The salaries of the optometrists represented by far the highest proportion of costs, accounting for 54.1% of the total.
Economic benefits are not realised until the fifth year (2013) when the first optometrists graduate and enter the public health system. By 2049, after applying a 3% discount rate, a NPV gross societal benefit $1.2 billion using the new DWs. This represents the value of correcting the URE of 24.3 million patients who are potentially economically productive.

5.4 Cost Benefit Analysis

Using the new DWs, the present value of the annual net societal benefit is negative until 2014. From 2014 there is a positive annual net societal benefit. This continues until the end of the analysis. By 2049, a NPV of $1.1 billion in societal benefits is realised. The results can be seen in Table 7.
Table 7 – Costs and benefits ($) of the optometry programme with 3% discounting

<table>
<thead>
<tr>
<th>Year</th>
<th>Costs ($)</th>
<th>Annual gross benefits for New DWs</th>
<th>NPV of societal benefits for New DWs</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>273,596</td>
<td>0</td>
<td>273,596</td>
</tr>
<tr>
<td>2010</td>
<td>529,534</td>
<td>0</td>
<td>495,836</td>
</tr>
<tr>
<td>2011</td>
<td>630,384</td>
<td>0</td>
<td>630,384</td>
</tr>
<tr>
<td>2012</td>
<td>595,349</td>
<td>0</td>
<td>595,349</td>
</tr>
<tr>
<td>2013</td>
<td>850,500</td>
<td>542,209</td>
<td>-</td>
</tr>
<tr>
<td>2014</td>
<td>1,111,769</td>
<td>2,180,867</td>
<td>1,069,098</td>
</tr>
<tr>
<td>2015</td>
<td>1,049,917</td>
<td>4,691,017</td>
<td>3,641,100</td>
</tr>
<tr>
<td>2016</td>
<td>1,137,230</td>
<td>7,726,506</td>
<td>6,589,276</td>
</tr>
<tr>
<td>2017</td>
<td>1,297,964</td>
<td>10,856,474</td>
<td>9,558,510</td>
</tr>
<tr>
<td>2018</td>
<td>1,393,939</td>
<td>13,797,559</td>
<td>12,403,620</td>
</tr>
<tr>
<td>2019</td>
<td>1,555,775</td>
<td>16,558,109</td>
<td>15,002,333</td>
</tr>
<tr>
<td>2020</td>
<td>1,636,562</td>
<td>19,146,145</td>
<td>17,509,583</td>
</tr>
<tr>
<td>2021</td>
<td>1,779,711</td>
<td>21,569,375</td>
<td>19,789,664</td>
</tr>
<tr>
<td>2022</td>
<td>1,846,736</td>
<td>23,835,203</td>
<td>21,988,467</td>
</tr>
<tr>
<td>2023</td>
<td>1,972,810</td>
<td>25,950,743</td>
<td>23,977,934</td>
</tr>
<tr>
<td>2024</td>
<td>2,027,388</td>
<td>27,922,828</td>
<td>25,895,440</td>
</tr>
<tr>
<td>2025</td>
<td>2,137,875</td>
<td>29,758,019</td>
<td>27,620,144</td>
</tr>
<tr>
<td>2026</td>
<td>2,181,214</td>
<td>31,462,618</td>
<td>29,281,404</td>
</tr>
<tr>
<td>2027</td>
<td>2,277,489</td>
<td>33,042,675</td>
<td>30,765,186</td>
</tr>
<tr>
<td>2028</td>
<td>2,310,699</td>
<td>34,503,999</td>
<td>32,193,300</td>
</tr>
<tr>
<td>2029</td>
<td>2,394,029</td>
<td>35,852,166</td>
<td>33,458,137</td>
</tr>
<tr>
<td>2030</td>
<td>2,418,130</td>
<td>37,092,528</td>
<td>34,674,398</td>
</tr>
<tr>
<td>2031</td>
<td>2,489,684</td>
<td>38,230,221</td>
<td>35,740,537</td>
</tr>
<tr>
<td>2032</td>
<td>2,505,613</td>
<td>39,270,174</td>
<td>36,764,561</td>
</tr>
<tr>
<td>2033</td>
<td>2,566,468</td>
<td>40,217,115</td>
<td>37,650,646</td>
</tr>
<tr>
<td>2034</td>
<td>2,575,084</td>
<td>41,075,580</td>
<td>38,500,496</td>
</tr>
<tr>
<td>2035</td>
<td>2,626,233</td>
<td>41,849,919</td>
<td>39,223,686</td>
</tr>
<tr>
<td>2036</td>
<td>2,628,323</td>
<td>42,544,306</td>
<td>39,915,983</td>
</tr>
<tr>
<td>2037</td>
<td>2,670,680</td>
<td>43,162,740</td>
<td>40,492,060</td>
</tr>
<tr>
<td>2038</td>
<td>2,666,963</td>
<td>43,709,057</td>
<td>41,042,094</td>
</tr>
<tr>
<td>2039</td>
<td>2,701,369</td>
<td>44,186,933</td>
<td>41,485,564</td>
</tr>
<tr>
<td>2040</td>
<td>2,692,507</td>
<td>44,599,892</td>
<td>41,907,385</td>
</tr>
<tr>
<td>2041</td>
<td>2,719,735</td>
<td>44,951,310</td>
<td>42,231,575</td>
</tr>
<tr>
<td>2042</td>
<td>2,706,330</td>
<td>45,244,420</td>
<td>42,538,091</td>
</tr>
<tr>
<td>2043</td>
<td>2,727,090</td>
<td>45,482,323</td>
<td>42,755,233</td>
</tr>
<tr>
<td>2044</td>
<td>2,709,693</td>
<td>45,667,985</td>
<td>42,958,292</td>
</tr>
<tr>
<td>2045</td>
<td>2,724,639</td>
<td>45,804,247</td>
<td>43,079,608</td>
</tr>
<tr>
<td>2046</td>
<td>2,703,752</td>
<td>45,893,830</td>
<td>43,190,077</td>
</tr>
<tr>
<td>2047</td>
<td>2,713,483</td>
<td>45,939,337</td>
<td>43,225,854</td>
</tr>
<tr>
<td>2048</td>
<td>2,689,565</td>
<td>45,943,259</td>
<td>43,253,695</td>
</tr>
<tr>
<td>2049</td>
<td>2,694,629</td>
<td>45,907,981</td>
<td>43,213,352</td>
</tr>
<tr>
<td>Total</td>
<td>83,920,439</td>
<td>1,206,169,667</td>
<td>1,122,282,925</td>
</tr>
</tbody>
</table>
The BCR can be used to evaluate the economic merit of a programme. A ratio where the benefits are greater than 1 suggests the programme is economically justifiable. Using the new DWs after discounting, the BCR is 14:1. The cumulative net societal benefits are positive by 2049. Initial costs associated with implementing the programme are eclipsed by the much higher benefits realised in later years.

5.5 Sensitivity analysis

Methodological sensitivity to the discount rate was tested, and the results indicated that the outcome of the study did not change until a 72% discount rate was applied, at which point the NPV of societal benefits for new DWs became negative. Without including any discounting at all, by 2049, a total of $2.5 billion in societal benefits is recorded.

Further investigation into the sensitivity of the methodology was implemented by comparing four scenarios based on different assumptions:

- Scenario 1 was the most conservative in comparison to the other three. It assumed that spectacles would only be effective for two years instead of four years and the salary of optometrists was doubled. It employed the revised DWs.
- Scenario 2 employed the same assumptions as scenario 1, but maintained the salaries at the original level detailed in the main body of the study.
- Scenario 3 represented the assumptions used in the main analysis and were included to allow comparison.
Scenario 4 was the least conservative. It employed the same assumptions as scenario 3, but used the original DW as opposed to the new DWs.

Scenario 1 found that by 2049, $649 million in societal benefits would be realised. Scenario 2 found that by 2049, $695 million in societal benefits would be realised. As described in the main analysis, scenario 3 resulted in a net societal benefit of $1.1 billion by 1949. For the first 3 scenarios the annual net societal benefit is negative until 2013 and positive from 2014 until the end of the time period analysed. Scenario 4 found that the annual net societal benefit is negative until 2012. From 2013 until the end of the time period analysed, it is positive. By 2049, a NPV of $9.6 billion of societal benefits will have been realised. Table 8 indicates the results of the sensitivity analysis, showing the NPV of societal benefits at 3% discount rate for the four scenarios analysed.

The sensitivity analysis found that regardless of parameter changes to assumptions made about the costs, benefits or DWs, a positive net societal benefit is realised very soon after the optometrists graduate and commence work. Even when assumptions were extremely conservative, $649 million in societal benefits could be realised by 2049. When less conservative assumptions were used, the model found that $9.6 billion in societal benefits could be realised by 2049.
Table 8 - Sensitivity analysis, showing the NPV of societal benefits ($) at 3% discount rate

<table>
<thead>
<tr>
<th>Year</th>
<th>Scenario 1 (Most conservative)</th>
<th>Scenario 2 (Main analysis)</th>
<th>Scenario 3 (Least conservative)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>273,596</td>
<td>273,596</td>
<td>273,596</td>
</tr>
<tr>
<td>2010</td>
<td>529,534</td>
<td>529,534</td>
<td>529,534</td>
</tr>
<tr>
<td>2011</td>
<td>630,384</td>
<td>630,384</td>
<td>630,384</td>
</tr>
<tr>
<td>2012</td>
<td>595,349</td>
<td>595,349</td>
<td>595,349</td>
</tr>
<tr>
<td>2013</td>
<td>367,550</td>
<td>308,291</td>
<td>3,488,585</td>
</tr>
<tr>
<td>2014</td>
<td>888,281</td>
<td>1,069,098</td>
<td>16,340,863</td>
</tr>
<tr>
<td>2015</td>
<td>2,962,544</td>
<td>3,257,787</td>
<td>36,490,477</td>
</tr>
<tr>
<td>2016</td>
<td>4,766,531</td>
<td>5,171,568</td>
<td>60,695,009</td>
</tr>
<tr>
<td>2017</td>
<td>6,381,097</td>
<td>6,891,706</td>
<td>85,582,197</td>
</tr>
<tr>
<td>2018</td>
<td>7,951,997</td>
<td>8,561,685</td>
<td>109,022,588</td>
</tr>
<tr>
<td>2019</td>
<td>9,353,422</td>
<td>10,055,984</td>
<td>130,952,363</td>
</tr>
<tr>
<td>2020</td>
<td>10,736,905</td>
<td>11,526,413</td>
<td>151,582,628</td>
</tr>
<tr>
<td>2021</td>
<td>11,963,473</td>
<td>12,891,706</td>
<td>170,831,650</td>
</tr>
<tr>
<td>2022</td>
<td>13,175,878</td>
<td>14,122,553</td>
<td>188,897,173</td>
</tr>
<tr>
<td>2023</td>
<td>14,243,047</td>
<td>15,260,443</td>
<td>205,700,950</td>
</tr>
<tr>
<td>2024</td>
<td>15,299,457</td>
<td>16,382,653</td>
<td>221,428,203</td>
</tr>
<tr>
<td>2025</td>
<td>16,221,484</td>
<td>17,365,783</td>
<td>236,004,039</td>
</tr>
<tr>
<td>2026</td>
<td>17,135,814</td>
<td>18,336,738</td>
<td>249,601,945</td>
</tr>
<tr>
<td>2027</td>
<td>17,925,847</td>
<td>19,179,126</td>
<td>262,150,254</td>
</tr>
<tr>
<td>2028</td>
<td>18,710,928</td>
<td>20,012,494</td>
<td>273,811,454</td>
</tr>
<tr>
<td>2029</td>
<td>19,381,081</td>
<td>20,727,058</td>
<td>284,516,982</td>
</tr>
<tr>
<td>2030</td>
<td>20,048,738</td>
<td>21,435,435</td>
<td>294,419,018</td>
</tr>
<tr>
<td>2031</td>
<td>20,610,173</td>
<td>22,034,076</td>
<td>303,451,982</td>
</tr>
<tr>
<td>2032</td>
<td>21,171,301</td>
<td>22,629,065</td>
<td>311,758,393</td>
</tr>
<tr>
<td>2033</td>
<td>21,634,290</td>
<td>23,122,736</td>
<td>319,275,539</td>
</tr>
<tr>
<td>2034</td>
<td>22,098,919</td>
<td>23,615,022</td>
<td>326,136,888</td>
</tr>
<tr>
<td>2035</td>
<td>22,472,915</td>
<td>24,013,802</td>
<td>332,282,479</td>
</tr>
<tr>
<td>2036</td>
<td>22,850,274</td>
<td>24,413,215</td>
<td>337,837,298</td>
</tr>
<tr>
<td>2037</td>
<td>23,143,969</td>
<td>24,726,372</td>
<td>342,744,030</td>
</tr>
<tr>
<td>2038</td>
<td>23,442,547</td>
<td>25,041,952</td>
<td>347,119,710</td>
</tr>
<tr>
<td>2039</td>
<td>23,663,927</td>
<td>25,278,002</td>
<td>350,909,562</td>
</tr>
<tr>
<td>2040</td>
<td>23,891,525</td>
<td>25,518,058</td>
<td>354,223,173</td>
</tr>
<tr>
<td>2041</td>
<td>24,047,924</td>
<td>25,684,821</td>
<td>357,008,204</td>
</tr>
<tr>
<td>2042</td>
<td>24,211,708</td>
<td>25,856,984</td>
<td>359,367,261</td>
</tr>
<tr>
<td>2043</td>
<td>24,309,858</td>
<td>25,961,637</td>
<td>361,250,344</td>
</tr>
<tr>
<td>2044</td>
<td>24,416,403</td>
<td>26,072,910</td>
<td>362,753,520</td>
</tr>
<tr>
<td>2045</td>
<td>24,462,476</td>
<td>26,122,035</td>
<td>363,829,028</td>
</tr>
<tr>
<td>2046</td>
<td>24,517,815</td>
<td>26,178,842</td>
<td>364,566,810</td>
</tr>
<tr>
<td>2047</td>
<td>24,517,466</td>
<td>26,178,469</td>
<td>364,921,255</td>
</tr>
<tr>
<td>2048</td>
<td>24,527,126</td>
<td>26,186,696</td>
<td>364,976,564</td>
</tr>
<tr>
<td>2049</td>
<td>24,485,533</td>
<td>26,142,345</td>
<td>364,689,185</td>
</tr>
</tbody>
</table>

Total 649,226,258 694,630,676 1,122,249,228 9,568,588,737
5.6 Discussion

During the early years of the programme, funds are spent to establish the optometry school but no benefits are realised until the first optometrists start work. This period of high costs and no return is to be expected as a normal implementation phase for any human resources development programme. The negative NPV of social benefits is illustrated in Figure 19, where it is clear that the values are negative for the first few years of the programme. Investments have been made but the benefits are yet to be realised.

Figure 18 – Sensitivity analysis, showing the NPV of societal benefits ($) at 3% discount rate across time
In the years following the implementation phase, the annual BCRs indicate a positive return on investment. With competition for limited resources and funds coming from both outside and within health systems, optometry is shown to be worthy of investment due to the potential for societal benefit. The results complement those of existing literature, which found interventions that address URE to be economically justifiable (Resnikoff et al 2008, Dandona & Dandona 2001 b, Holden et al 2008, Ramke et al 2008).

The new DWs for blindness and VI have been the subject of much debate. The VLEG has expressed concern at how low the new DWs are compared to the previous weighting, particularly noting variations in the formulation of the lay survey questions pertaining to different health conditions. Vision and hearing loss are notable outliers in the 2010 GBD study. When compared to the assigned DWs for moderate skin disfigurement with itch or pain (0.187), mild alcoholism
(0.259), moderate rheumatoid arthritis (0.292), or even a pain in the neck (0.221), the VLEG authors note that the new DWs for blindness and VI simply do not pass the “common sense test”. VLEG calls for the new DWs to be investigated further prior to their widespread adoption (Taylor et al 2013).

The GBD authors have defended the new DWs, by stating that the definitions of blindness and VI were informed through consultation with VLEG and that the weights were informed by a series of measurement surveys, in which 30,000 people participated. They also issued a warning not to use previous weights as if they were a reference standard (Salomon et al 2013). The results of this study exemplify the impact that revising DWs can have on the assessment of an intervention. In the case of the burden of URE as addressed herein, the range of societal benefits that are projected vary nine fold, from $1.1 billion for the revised DWs to $9.6 billion for the original DW.

Many CBA methodologies are available, and different theories exist in relation to which costs and benefits to include. In the current study no building costs were included as the Universidade Lúrio campus was already established. Also the costs of lenses and frames were excluded, as the spectacles would be sold at least for a nominal fee to cover costs. To keep the analysis conservative, net profit from sale of spectacles was not included. This revenue has potential to contribute not only to the economic stability and sustainability of the refraction service, but of a complete eye health department (Holden et al 2008, West & Sommer 2001, Rahmathullah et al 2007).

Establishing services that engage in cost recovery are influenced by not only the availability and quality of services but the appropriateness of the service in terms of costs to the patients. The following chapters address people’s WTP for refractive services and seek to establish if any
barriers to access exist. Quality of delivery, as well as supply and distribution processes will determine how successful the programme is (Dandona & Dandona 2001b, Holden et al 2000). Further research on this is needed. Acceptance is also a factor. The compliance ratio has a direct relationship with the benefits realised. The study assumes 100% spectacle wear compliance for patients with refractive error, which may not be the case. If half of the patients rejected the spectacles or took them but never wore them, then the benefits would also be reduced by half. Also, addressing URE does not guarantee the emergence of economic productivity. The conditions and environment will need to be conducive to economic opportunity or entrepreneurial opportunity for productivity to flourish after URE is addressed.

As in any CBA study, judgements were made concerning the inclusion of cost and benefit items and assumptions were made concerning their size and/or incidence. For the base case scenario, these judgements were always conservative and so reduced the estimated societal benefit. The sensitivity analysis tested the robustness of the methodology against changing assumptions. Inflation costs were excluded, as per standard CBA methodology (Sinden & Thampapillai 1995). This study builds on existing literature, in which economic analyses have been employed to estimate the value derived from addressing blindness and VI. One study found that addressing URE has the potential for the greatest impact on the global economy compared to all other preventable vision disorders (Smith et al 2009). Another found investing in eye health in The Gambia to be economically justifiable and a third found that globally, in excess of $100 billion in lost productivity could be avoided if all the targets set by VISION 2020 are achieved for the period from 2003 to 2020 (Frick & Foster 2003, Frick et al 2005). Focusing exclusively on the impact of VI caused by URE on economic productivity, it was estimated that the global loss associated with this burden was $268.8 billion after adjustment for LFPR and ER. While direct
comparison between studies is challenging due to differences in scale and scope, both the global study and the current national level study for Mozambique provide sound economic reasoning to invest in interventions that address URE and reduce the burden of VI (Smith et al 2009).

The study assumes that the graduation rate remains constant after the pilot year. In reality, the number of students and optometrists will increase as the course becomes more established and the cadre develops. The enrolment rate in the study was deliberately conservatively low. If enrolment increased, so would some costs, but not all. For example, educational material costs would stay the same, but school equipment costs would need to increase in proportion to the number of students. If the CBA model is updated to assume double the number of students graduate each year, to represent the VISION 2020 target of one optometrist per 50,000 people, subject to a 3% discount rate, a NPV societal benefit of $2.3 billion when using the new DWs could be realised by 2049. This represents the value of correcting the URE of 48.6 million patients who are potentially economically productive by 2049. The annual BCR remains virtually static as an increase in students and graduates increases both the costs and benefits.

The focus of the current study is URE but optometrists can also reduce the burden of blindness and VI caused by other diseases and conditions - the benefits of which are not reported here. Blindness and VI are further associated with additional indirect health effects and costs. An effective programme to address avoidable vision loss will generate cost savings, as, for example, the rates of falls, fractures, motor vehicle accidents and conditions such as depression attributable to low vision are reduced. Premature death due to blindness and VI would also result in a future stream of productivity losses due to lost potential earnings. Such related cost savings and productivity gains are difficult to accurately quantify, and, therefore, not included in the model, but would serve to increase the net societal benefit.
Although URE is also a cause of blindness (VA < 3/60) which is afforded higher DWs relative to VI (Original DWs, 0.6; revised DWs 0.195), the prevalence data on blindness associated with URE is inconsistent, ranging from 1.1% to 7.9% in some studies, but with more than half of all studies across sub-Saharan Africa reporting zero blindness as a consequence of URE (Sherwin et al 2012). Due to the likely low overall blindness prevalence as a result of URE, the current study includes VI only, which reinforces the conservative nature of the societal benefit estimate.

Also, the burden of URE is, in reality, not limited to just the individual with VI. Families, societies and communities may also suffer the burden as they may be required to give up their time to perform certain tasks to assist or care for the person with VI. One study assumed that for each blind individual, a 10% loss of productivity would be experienced by a relative or someone in the community (Frick & Foster 2003). If the wider societal burden were to be included, net societal benefits of addressing the URE would increase. The current study focuses on people of productive age. It does not consider that if the URE of a child is addressed, this would be expected to maximise their future economic productivity through improved education and consequentially enhanced employment opportunities.

5.7 Conclusion

The development of optometry has been shown to have the potential to achieve a NPV societal benefit of $1.1 billion by 2049 in Mozambique using conservative DWs and after applying a 3% discount rate. Investment in optometry is shown to be attractive and justifiable in economic terms. When CBA assumptions are varied as part of the sensitivity analysis, the results suggest the societal benefit could lie in the range of $649 million to $9.6 billion by 2049, depending on
how conservative the assumptions are. While costs can be justified, as they are far outweighed by the benefits optometrists bring, they still present a large cash outflow for the public health sector of a low income country. Careful planning is needed to ensure the budget is available to employ the optometrists trained within the public sector. If the budgetary resources are not available to pay the optometrists wages, they will either seek employment in the private sector or possibly look to emigrate. Either of these scenarios would result in the burden of URE in Mozambique remaining high.

To conclude, the results reinforce observations from other national and international eye health studies that suggest that investment in eye health, and particularly programmes that address URE, provide good value for money and can be justified economically.
Chapter 6. Barriers to utilisation of refractive services in Mozambique

6.1 Introduction

Mozambique has a population of over 25 million people (World Bank 2014 a). Nampula Province in Northern Mozambique has just under 4 million people (INE 2014). Although Mozambique is currently experiencing unprecedented economic growth rates, buoyed by the discovery of natural resources, significant challenges remain for the population, such as adequate health care, including eye health services.

VISION 2020 is a global initiative to eliminate avoidable blindness by the year 2020. Its core strategies are focused on human resource development, infrastructure development and disease control (WHO 2010 a). The MEP output of delivering a regional optometry model for Lusophone Africa, which included a higher education programme for optometry in Mozambique, was based on the VISION 2020 core strategies. Mozambique’s first professional optometrists graduated from Universidade Lúrio in 2013. To achieve the VISION 2020 goals, the services the optometrists are trained to provide must be fully implemented. To realise this potential, the utilisation of refraction services by the general public must be fully understood (Marmamula et al 2011).

The body of evidence that exists in relation to the uptake of eye health services is limited. Research suggests that cost is the most significant barrier to eye health services (Marmamula et al 2011, Kuper et al 2008, Laviers et al 2011). Indirect costs, such as transport, food and lodgings, may also limit uptake (Melese et al 2004). However, if cost as a barrier is removed, service uptake is not guaranteed (Sommer 1995). Even when eye health services are provided at
no cost, not all patients choose to access them (Preslan & Novak 1998, Keeffe et al 2002). In some instances people with eye health needs may be unaware of free or subsidised services. A lack of information about the service may be as much of a barrier as cost (Dandona et al 2000). The significance of cost as a barrier may change with time. With readymade spectacles, which provide a suitable correction for a significant proportion of refractive errors, now costing as little as $1 per pair to source, cost may no longer be a substantial barrier to usage for many individuals (Ramke et al 2007).

Eye health services tend to be focused on urban areas of high population density, yet many people live in rural areas. Distance to services may therefore be a barrier (Lewallen & Courtright 2001). The journey to access services may be particularly difficult for those with VI. Gender must also be considered in this context. Unaccompanied travel for long distances may present different barriers for men and women in different societies (Gurung 2007). Entrenched cultural and religious beliefs may also present barriers (Resnikoff et al 2008). Whether these beliefs involve religion, ideas of destiny, or societal attitudes towards gender, disability or ethnicity, they may limit service uptake (Lewallen & Courtright 2001, Ebeigbe 2013, George & Iyer 2013). The perception that vision loss is an untreatable and irreversible consequence of ageing may also need to be countered (Keeffe et al 2002).

People may be unaware they even have an eye health problem. A lack of awareness of general eye health and the interventions available may limit uptake. Those needing treatment may not understand the time needed for the intervention, the costs involved, whether it will hurt or not, and the chances of achieving a successful outcome (Lewallen & Courtright 2001). Eye health education and the provision of information may be key to overcoming these barriers (Abdulla et al 2012). Quality of services will influence future uptake. Adequate health infrastructure and the
suitability/quality of staff training are important determinants of the influence of such experience/outcomes related barriers (Taylor & Keeffe 2001). Bullying, ridicule and peer victimisation potentially may also limit service uptake or reduce compliance, particularly with regards to children with eye health problems. Carlton et al 2008 Strategies to improve the compliance of spectacle wear may be needed (O’Donoghue et al 2010).

Understanding the barriers to a refractive service will be central to the ultimate success of the intervention (Dandona & Dandona 2001 a). This study has been designed to gain an understanding of the barriers to accessing refractive services perceived by the general population in Mozambique.

6.2 Methods

A population-based cross-sectional study was conducted using two-stage cluster sampling in Nampula Province, between 2012 and 2013. This was completed alongside a RARE study, designed to determine the prevalence of refractive error and presbyopia, assess spectacle coverage, and evaluate eye health related quality of life perspectives amongst persons in Nampula (Loughman et al 2014). RARE studies are community-based cross-sectional studies that followed a standardised methodology, including the completion of a demographic questionnaire, a standardised ophthalmic assessment to determine refractive status and spectacle coverage, and a modified vision related quality of life questionnaire to assess the impact of URE on participant’s eye health status. RARE studies have been successfully employed in other countries in the region, including Eritrea (Chan et al 2013).
For the current study, clusters were defined by the administrative level of ‘Bairro’, meaning neighbourhood (INE 2014). There are 395 Bairros in Nampula Province, with populations ranging from less than 100 to several thousand. 76 bairros were randomly selected for enumeration using a systematic random sampling method with probability proportional to size (PPS). A minimum of 60 participants were included per cluster. If more time and resources were available, the number of people sampled from each cluster would correlate to the population of each bairro. The calculation of sample size that was used was based on several aspects including the required precision of the estimate, confidence levels and the expected prevalence of refractive error, which was set at 5% of the population, as there was no formal estimate available. As the exact prevalence of refractive error was not known and statistical data for the population of Nampula Province is limited, the sample of this study was set at a level to far exceed the necessary sample size required for the validation of the methodology. Cluster random sampling allowed 4,601 individuals to be enumerated from the selected 76 clusters. The sampling was conducted in a manner that each individual participating has the same participation weight and an equal probability of selection; therefore it is a self-weighting sample.

There is no single definition of urban or rural habitation (UNSD 2013). As such, an assessment was made for each cluster as to whether it was a rural or urban based on a brief assessment of household access to treated water and electricity supply, population density and the presence of surfaced roads.

To be included in the study, participants needed to be at least 15 years of age, residing permanently at the address and actively involved in making financial decisions in the household. Those people found to not meet these criteria were excluded.
Participants were interviewed to establish barriers to the uptake of refractive services, using a pre-coded questionnaire. The barrier options presented were informed by existing relevant literature and stakeholder meetings involving social scientists, eye health professionals, students and members of the public. The objective of the meetings was to ensure the barriers were appropriate for the Mozambican context and that no other barriers needed to be included. VA was assessed by either a qualified optometrist or by an optometry student enrolled at Universidade Lúrio, who had completed at least two years of study, under the supervision of a qualified optometrist. VI was defined using the categories as illustrated in Table 9. For each participant with confirmed VI, the barriers listed in Table 10 were presented in a randomised order.

**Table 9 – VI category definition by visual acuity* in the better eye (Bourne et al 2013)**

<table>
<thead>
<tr>
<th>VI category</th>
<th>Definition by visual acuity* in the better eye</th>
</tr>
</thead>
<tbody>
<tr>
<td>No VI</td>
<td>≥6/12</td>
</tr>
<tr>
<td>Distance VI (mild to severe)</td>
<td>&lt;6/12 but ≥3/60</td>
</tr>
<tr>
<td>Near VI</td>
<td>&lt;6/12 but ≥3/60 for near, but ≥6/12 for distance</td>
</tr>
</tbody>
</table>

*Snellen VA or the equivalent calculated from published LogMAR values.

A pilot study was conducted, which allowed for the protocol on enumeration, face-to-face interviews, clinical assessments and data recording to be refined. It also allowed the suitability of the methodology to be verified and informed planning for the logistical requirements of the data collection. With the finalised questionnaire, participants were asked to select up to three barriers that represented their experience of accessing eye health services for refractive error. Participants were informed that if they felt strongly that they needed to select more barriers to reflect their
experiences, they could do so. A subset of participants (25% of the total interviewed) were selected at random to answer questions on salaries and family finances.

Table 10 - Barriers

<table>
<thead>
<tr>
<th>Category</th>
<th>Barrier</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I am unaware of the problem</td>
</tr>
<tr>
<td>2</td>
<td>I am aware of the problem but my eyes are not yet bad enough to seek treatment</td>
</tr>
<tr>
<td>3</td>
<td>The cost of treatment</td>
</tr>
<tr>
<td>4</td>
<td>Hospital services are not adequate</td>
</tr>
<tr>
<td>5</td>
<td>Distance - services are too far away</td>
</tr>
<tr>
<td>6</td>
<td>I have other health priorities</td>
</tr>
<tr>
<td>7</td>
<td>Time – I do not have enough time to seek treatment</td>
</tr>
<tr>
<td>8</td>
<td>Ridicule – I will be teased if I seek treatment</td>
</tr>
<tr>
<td>9</td>
<td>Visual impairment is destiny or God’s will</td>
</tr>
<tr>
<td>10</td>
<td>I fear my eyesight will get worse with treatment</td>
</tr>
<tr>
<td>11</td>
<td>A family member is restricting me from accessing services</td>
</tr>
<tr>
<td>12</td>
<td>Visual impairment is normal with aging</td>
</tr>
<tr>
<td>13</td>
<td>Other</td>
</tr>
</tbody>
</table>

Ethics committee approval was granted for the study by the National Ethics Committee of Mozambique (Comité Nacional de Bioética para Saúde) and under the MEP by DIT’s ethics committee. The research followed the tenets of the Declaration of Helsinki and informed consent was obtained from the subjects after an explanation of the study. Data were coded for anonymity.
All data recorded were kept locked away. During the data collection phase, data were checked twice for consistency, once by an optometrist, once by a social scientist. An error log sheet was developed. Where possible, discrepancies were addressed in the field. The data were recorded in a custom database designed in Microsoft Excel. Data were analysed using SPSS (version 21).

Figure 20 – Data collection for the barriers study
6.3 Results

From the 4,601 individuals enumerated, 1,817 (39%) were from rural areas and 2,784 (61%) were from urban areas. A total of 1,087 (24%) people were found to have VI and were willing to participate by stating which barriers they perceived were restricting their access to refractive services. From the 3,514 responses excluded, 3,377 (96%) had no VI and 137 (4%) had VI but did not want to state barriers experienced. From those excluded, 1,621 (46%) were male and 1,893 (54%) were female, while 2,050 (58%) were from urban areas as opposed to 1,464 (42%) from rural areas.

From the 4,601 individuals enumerated, a subset of 1,144 were asked about their financial situation. From that subset, only 315 participants who had given information on their financial situation were found to have VI and were willing to participate by stating which barriers they perceived were restricting their access to refractive services. The subset of participants that provided information on their financial situation was made up of 315 participants, equating to 29% of all the participants found to have VI and were willing to participate by stating which barriers affected them. From the subset, 192 (61%) participants in the subset came from rural areas, while 123 (39%) participants came from urban areas. From the subset, 176 (56%) participants were male, while 139 (44%) were female. Further details of participant characteristics are shown in Table 1.

The average number of barriers cited per participant was 1.5 (±0.65), with a total of 1,630 barriers cited in total. Only four participants selected more than three barriers, each citing four barriers.
Table 11 - Participant characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Frequency</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>555</td>
<td>51.1</td>
</tr>
<tr>
<td>Female</td>
<td>532</td>
<td>48.9</td>
</tr>
<tr>
<td><strong>Location</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rural</td>
<td>357</td>
<td>32.8</td>
</tr>
<tr>
<td>Urban</td>
<td>730</td>
<td>67.2</td>
</tr>
<tr>
<td><strong>Occupation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Business owner</td>
<td>19</td>
<td>1.7</td>
</tr>
<tr>
<td>Unspecified but formally employed</td>
<td>14</td>
<td>1.3</td>
</tr>
<tr>
<td>Student</td>
<td>20</td>
<td>1.8</td>
</tr>
<tr>
<td>Guard</td>
<td>10</td>
<td>0.9</td>
</tr>
<tr>
<td>Teacher</td>
<td>44</td>
<td>4</td>
</tr>
<tr>
<td>Domestic worker</td>
<td>3</td>
<td>0.3</td>
</tr>
<tr>
<td>Vendor</td>
<td>22</td>
<td>2</td>
</tr>
<tr>
<td>Farmer</td>
<td>489</td>
<td>45</td>
</tr>
<tr>
<td>Armed services/police</td>
<td>29</td>
<td>2.7</td>
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<tr>
<td>Housewife</td>
<td>83</td>
<td>7.6</td>
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<tr>
<td>Unemployed</td>
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<td>11</td>
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<tr>
<td>Other</td>
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<td>20</td>
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<tr>
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<td>17</td>
<td>1.6</td>
</tr>
<tr>
<td><strong>Education</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No secondary education</td>
<td>960</td>
<td>88.3</td>
</tr>
<tr>
<td>Finished secondary</td>
<td>110</td>
<td>10.1</td>
</tr>
<tr>
<td>Degree</td>
<td>5</td>
<td>0.5</td>
</tr>
<tr>
<td>Not stated</td>
<td>12</td>
<td>1.1</td>
</tr>
<tr>
<td><strong>Individual Salary</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Individual salary &lt;US2 per day</td>
<td>261</td>
<td>82.9</td>
</tr>
<tr>
<td>Individual salary &gt;US2 per day</td>
<td>54</td>
<td>17.1</td>
</tr>
<tr>
<td><strong>Family Salary</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Family salary &lt;US2 per day</td>
<td>239</td>
<td>75.9</td>
</tr>
<tr>
<td>Family salary &gt;US2 per day</td>
<td>76</td>
<td>24.1</td>
</tr>
</tbody>
</table>

Cost was the most frequently stated barrier, identified by 579 out of 1,087 participants, equating to a positive response from 53% of the participants interviewed, and comprising 36% of the total barriers selected. A total of 304 participants (28%) stated that although they were aware of a problem, they felt it was not bad enough to seek treatment, equating to 19% of all responses. The distance to services was identified by 161 participants (15%) as a barrier, equating to 10% of all
responses. Figures 21 and 22 indicate the frequency that each barrier was stated. The response to two of the barrier options - fear of eyesight getting worse with treatment and a family member restricting access – equated to less than 1% of the responses for each. No solid conclusions could be drawn from such low frequency of responses, so these barrier options were not included in the statistical analysis.

![Graph showing frequency of barriers stated](image)

**Figure 21 - The frequency that each barrier was stated**

Pearson chi-squared analysis indicated that gender did not have a significant association with the selection of barriers, other than the response that VI is destiny or God’s will (p = 0.018), with females 0.34 (0.134 - 0.864) times less likely to report destiny or God’s will as a barrier compared to males. However, the proportions of positive responses were relatively low, only 6 (1%) females stated destiny/God’s will as a barrier, as opposed to 18 (3%) males.
The location of the participant’s dwelling was found to have a significant association with six of the barriers selected. Participants from rural areas were found to feel disadvantaged regarding the distance \((p < 0.001)\) and adequacy of hospital services \((p < 0.001)\). Participants from rural areas were 2.13 \((1.789-2.543)\) times and 1.64 \((1.207-2.234)\) times more likely to report distance and adequacy of hospital services as a barrier compared to their urban counterparts, respectively.

Also, significantly more rural participants stated being unaware \((p = 0.002)\), destiny/God’s will \((p = 0.002)\), and the perception that VI due to old age is untreatable or irreversible \((p = <0.001)\) as being barriers, although the frequencies for the latter two barriers were relatively low. Rural participants were 1.20 \((1.000-1.433)\), 1.88 \((1.234-2.848)\) and 1.65 \((1.244-2.184)\) times more likely to report unawareness, destiny/God’s will and the perception that VI due to old age is untreatable or irreversible as a barrier compared to their urban counterparts, respectively.

However, significantly less rural dwelling participants reported that their eyes were not bad enough to seek help \((p = <0.001)\) and they were 0.70 \((0.602 - 0.818)\) times less likely to state that
their eyes were not bad enough to seek help as a barrier compared to participants residing in the urban areas.

Formal secondary school education was found to be significantly associated with the reporting of being unaware (p = 0.016), cost (p = 0.014), distance (p = 0.005) and other (p = <0.001) as barriers. Participants with at least secondary education were 0.39 (0.179-0.862), 0.62 (0.416-0.909) and 0.34 (0.156 - 0.749) times less likely to report unawareness, cost and distance as a barrier, respectively. However, participants with at least secondary education were 2.64 (1.571-4.431) times more likely to report other barriers not included in the study. 87% of urban dwellers had no secondary school education compared to 94% in rural areas, indicating that education provision to rural areas is worse than urban areas.

Stratification of participants according to whether they exhibited near or distance VI impacted significantly on stated barriers only for those that cited barriers including: aware of the problem but their eyes were not yet bad enough to seek treatment (p = 0.017); hospital services adequacy (p = <0.001); other health priorities (p = 0.007); and those who stated that VI is normal with aging (p = 0.008). With regards to the strength and direction of association for the stated barriers, significant odds ratios are approximately equal to 1 (OR≈1.00) showing that the odds are almost equal for both groups of participants exhibiting near or distance VI. 261 (30%) participants with near VI stated that their eyes were not yet bad enough to seek treatment, as opposed to 43 (21%) participants with distance VI.

For the subset of participants that were asked about finances, it was found that personal income only had a significant impact on the barrier selection of hospital services adequacy (p = 0.004) and distance (p = <0.001). Participants with a personal income of more than US$2 per day were 2.80 (1.362-5.757) times more likely to report adequacy of hospital services compared to those
with a personal income of less than this value. On the other hand, participants with a personal income of more than US$2 per day were 0.10 (0.024-0.425) times less likely to report the distance to a service facility as a barrier compared to those with a personal income of less than this value. For family income, having a collective income of more than US$2 per day had a significant impact on the selection of the participant being unaware of a problem (p = 0.041), hospital services adequacy (p = 0.003) and distance (p = <0.001) being selected as barriers. Participants with a collective family income of more than US$2 per day were 0.40 (0.164-0.987) and 0.22 (0.089-0.520) times less likely to report being unaware of the problem and distance as a barrier, respectively. However, participants with a collective family income of more than US$2 per day were 2.66 (1.357-5.201) times more likely to report hospital services adequacy as a barrier compared to participants with collective family income of less than that value.

Trend analysis was conducted to test the relationship between age and the barriers selected. Results are as shown in Table 1, significant trends were obtained between ages and the following barriers; lack of felt need (p=0.001), cost (p=0.004), hospital services (p=0.017), distance (p<0.001), other priorities (p<0.001) and VI is normal with aging (p<0.001). Age odds ratios are in reference to the baseline age category of 15-29 years. Participants aged at least 70 years were 4.13 (1.37-12.43) and 9.64 (1.10-84.37) times more likely to report distance and that VI is normal with aging as a barrier compared to those aged between 15-29 years, respectively. On the other hand, participants of at least 70 years of age are 0.18 (0.04-0.85) times less likely to report eyes are not bad enough to seek treatment compared to participants aged between 15-29 years. In addition, participants aged between 50-69 years are 1.88 (1.01-3.52) times more likely to report cost as a barrier.
### Table 12 – Statistical analysis of variables (a-g)

#### a) Gender

<table>
<thead>
<tr>
<th></th>
<th>Not aware</th>
<th>Lack of felt need</th>
<th>Cost</th>
<th>Hospital Services</th>
<th>Distance</th>
<th>Other priorities</th>
<th>Time</th>
<th>Ridicule</th>
<th>Destiny</th>
<th>Age</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Count (%) M</td>
<td>71 (12.8)</td>
<td>148 (26.7)</td>
<td>296  (53.3)</td>
<td>26 (4.7)</td>
<td>86 (15.5)</td>
<td>36 (6.5)</td>
<td>57 (10.3)</td>
<td>11 (2)</td>
<td>18 (3.2)</td>
<td>29 (5.2)</td>
<td>56 (10.1)</td>
</tr>
<tr>
<td>Freq F (%)</td>
<td>74 (13.9)</td>
<td>156 (29.3)</td>
<td>283  (53.2)</td>
<td>17 (3.2)</td>
<td>75 (14.1)</td>
<td>36 (6.8)</td>
<td>50 (9.4)</td>
<td>16 (3)</td>
<td>6 (1.1)</td>
<td>23 (4.3)</td>
<td>47 (8.8)</td>
</tr>
</tbody>
</table>

| chi square P   | 0.588     | 0.329             | 0.964 | 0.208             | 0.517     | 0.853            | 0.630 | 0.277     | 0.018   | 0.486 | 0.480 |

| OR (95% CI)    | 1.101     | 0.776 - 1.563     | 1.141 | 0.875 - 1.487     | 0.994     | 0.784 - 1.262    | 0.672 | 0.360 - 1.253 | 0.895   | 0.640 - 1.252 | 0.906   | 0.60 - 1.352 | 1.406   | 0.649 - 1.252 | 0.994   | 0.784 - 1.252 | 1.333   | 0.705 - 3.335 |

|                | 1.340     | 0.134 - 0.864     | 1.642 | 1.234 - 2.848     | 1.406     | 0.961 - 1.564    | 1.233 | 0.961 - 1.564 | 1.874   | 1.234 - 2.848 | 1.649   | 1.244 - 2.184 | 1.004   | 0.809 - 1.246 |

#### b) Location

<table>
<thead>
<tr>
<th></th>
<th>Not aware</th>
<th>Lack of felt need</th>
<th>Cost</th>
<th>Hospital Services</th>
<th>Distance</th>
<th>Other priorities</th>
<th>Time</th>
<th>Ridicule</th>
<th>Destiny</th>
<th>Age</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Count (%) U</td>
<td>87 (11.9)</td>
<td>236 (32.3)</td>
<td>383  (52.5)</td>
<td>19 (2.6)</td>
<td>59 (8.1)</td>
<td>42 (5.8)</td>
<td>80 (11)</td>
<td>17 (2.3)</td>
<td>9 (1.2)</td>
<td>23 (3.2)</td>
<td>69 (9.5)</td>
</tr>
<tr>
<td>Freq R (%)</td>
<td>58 (16.2)</td>
<td>68 (19)</td>
<td>196  (54.9)</td>
<td>24 (6.7)</td>
<td>102 (28.6)</td>
<td>30 (8.4)</td>
<td>27 (7.6)</td>
<td>10 (2.8)</td>
<td>15 (4.2)</td>
<td>29 (8.1)</td>
<td>34 (9.5)</td>
</tr>
</tbody>
</table>

| chi square P   | 0.049     | <0.001            | 0.450 | 0.001             | <0.001   | 0.099            | 0.078 | 0.638     | 0.002   | <0.001 | 0.970 |

| OR (95% CI)    | 1.197     | 1.000 - 1.433     | 0.702 | 0.602 - 0.818     | 1.050    | 0.925 - 1.192    | 1.642 | 1.207 - 2.234 | 2.133   | 1.789 - 2.543 | 1.226   | 0.961 - 1.564 | 0.815   | 0.649 - 1.024 | 1.099   | 0.740 - 1.633 | 1.874   | 1.234 - 2.848 | 1.649   | 1.244 - 2.184 | 1.004   | 0.809 - 1.246 |

|                | 1.874     | 1.234 - 2.848     | 1.649 | 1.244 - 2.184     | 1.004    | 0.809 - 1.246    |
c) Education

<table>
<thead>
<tr>
<th></th>
<th>Not aware</th>
<th>Lack of felt need</th>
<th>Cost</th>
<th>Hospital Services</th>
<th>Distance</th>
<th>Other priorities</th>
<th>Time</th>
<th>Ridicule</th>
<th>Destiny</th>
<th>Age</th>
<th>Other</th>
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</thead>
<tbody>
<tr>
<td><strong>Freq NSE (%)</strong></td>
<td>136 (14.2)</td>
<td>261 (27.2)</td>
<td>525</td>
<td>37 (3.9)</td>
<td>153</td>
<td>61 (6.4)</td>
<td>93</td>
<td>22 (2.3)</td>
<td>23 (2.4)</td>
<td>45</td>
<td>(4.7)</td>
</tr>
<tr>
<td><strong>Freq ALS E (%)</strong></td>
<td>7 (6.1)</td>
<td>36 (31.3)</td>
<td>49</td>
<td>6 (5.2)</td>
<td>7 (6.1)</td>
<td>11 (9.6)</td>
<td>12</td>
<td>5 (4.3)</td>
<td>1 (0.9 )</td>
<td>7 (6.1)</td>
<td>22 (19.1)</td>
</tr>
<tr>
<td><strong>chi square P</strong></td>
<td><strong>0.016</strong></td>
<td>0.351</td>
<td><strong>0.014</strong></td>
<td>0.481</td>
<td><strong>0.005</strong></td>
<td>0.193</td>
<td>0.799</td>
<td>0.183</td>
<td>0.295</td>
<td>0.509</td>
<td><strong>&lt;0.001</strong></td>
</tr>
<tr>
<td><strong>OR (95% CI) NSE/ALS E</strong></td>
<td><strong>0.393</strong></td>
<td><strong>(0.179 - 0.862)</strong></td>
<td>1.220</td>
<td>0.615</td>
<td><strong>1.373</strong></td>
<td><strong>(0.567 - 3.328)</strong></td>
<td>0.342</td>
<td><strong>0.0567 - 0.749</strong></td>
<td>1.559</td>
<td><strong>0.0795 - 3.057</strong></td>
<td>1.086</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Not aware</th>
<th>Lack of felt need</th>
<th>Cost</th>
<th>Hospital Services</th>
<th>Distance</th>
<th>Other priorities</th>
<th>Time</th>
<th>Ridicule</th>
<th>Destiny</th>
<th>Age</th>
<th>Other</th>
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<tbody>
<tr>
<td><strong>Freq NVI (%)</strong></td>
<td>119 (13.5)</td>
<td>261 (29.5)</td>
<td>474</td>
<td>20 (2.3)</td>
<td>122</td>
<td><strong>50 (5.7)</strong></td>
<td>86</td>
<td>22 (2.5)</td>
<td>18 (2 )</td>
<td>35</td>
<td>(4)</td>
</tr>
<tr>
<td><strong>Freq DVI (%)</strong></td>
<td>26 (12.8)</td>
<td>43 (21.2)</td>
<td>105</td>
<td>23 (11.3)</td>
<td>39 (19.2)</td>
<td>22 (10.8)</td>
<td>21</td>
<td>5 (2.5)</td>
<td>6 (3)</td>
<td>17</td>
<td>(8.4)</td>
</tr>
<tr>
<td><strong>chi square P</strong></td>
<td><strong>0.805</strong></td>
<td><strong>0.017</strong></td>
<td>0.625</td>
<td><strong>&lt;0.001</strong></td>
<td>0.050</td>
<td><strong>0.007</strong></td>
<td>0.790</td>
<td>0.983</td>
<td>0.421</td>
<td><strong>0.008</strong></td>
<td>0.950</td>
</tr>
<tr>
<td><strong>OR (95% CI) NVI/DVI</strong></td>
<td>1.000</td>
<td><strong>(0.996 - 1.003)</strong></td>
<td><strong>0.996</strong></td>
<td><strong>(0.993 - 0.999)</strong></td>
<td>1.014</td>
<td><strong>(1.009 - 1.020)</strong></td>
<td>1.003</td>
<td><strong>(1.000 - 1.007)</strong></td>
<td>1.006</td>
<td><strong>(1.002 - 1.010)</strong></td>
<td>1.000</td>
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</tbody>
</table>

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### e) Income personal

<table>
<thead>
<tr>
<th></th>
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<th>Lack of felt need</th>
<th>Cost</th>
<th>Hospital Services</th>
<th>Distance</th>
<th>Other priorities</th>
<th>Time</th>
<th>Ridicule</th>
<th>Destiny</th>
<th>Age</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freq personal &lt;US$2/day (%)</td>
<td>44 (16.9)</td>
<td>24 (9.2)</td>
<td>161 (61.7)</td>
<td>29 (11.1)</td>
<td>72 (27.6)</td>
<td>39 (14.9)</td>
<td>46 (17.6)</td>
<td>3 (1.1)</td>
<td>13 (5)</td>
<td>45 (17.2)</td>
<td>17 (6.5)</td>
</tr>
<tr>
<td>Freq personal &gt; US$2/day (%)</td>
<td>4 (7.4)</td>
<td>3 (5.6)</td>
<td>29 (53.7)</td>
<td>14 (25.9)</td>
<td>2 (3.7)</td>
<td>10 (18.5)</td>
<td>9 (16.7)</td>
<td>0 (0)</td>
<td>1 (1.9)</td>
<td>7 (13)</td>
<td>5 (9.3)</td>
</tr>
<tr>
<td>chi square P</td>
<td>0.079</td>
<td>0.384</td>
<td>0.275</td>
<td><strong>0.004</strong></td>
<td>&lt;0.001</td>
<td>0.509</td>
<td>0.866</td>
<td>0.429</td>
<td>0.310</td>
<td>0.441</td>
<td>0.471</td>
</tr>
<tr>
<td>OR (95% CI) personal &lt; US$2/day / US$2/day</td>
<td>0.395 (0.136 - 1.149)</td>
<td>0.581 (0.168 - 2.003)</td>
<td>0.720 (0.399 - 1.300)</td>
<td><strong>2.800 (1.362 - 5.757)</strong></td>
<td><strong>0.101 (0.024 - 0.425)</strong></td>
<td>1.294 (0.601 - 2.784)</td>
<td>0.935 (0.427 - 2.046)</td>
<td>-</td>
<td>0.360 (0.046 - 2.811)</td>
<td>0.715 (0.304 - 1.684)</td>
<td>1.465 (0.516 - 4.157)</td>
</tr>
</tbody>
</table>

### f) Income family combined

<table>
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<tr>
<th></th>
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<th>Lack of felt need</th>
<th>Cost</th>
<th>Hospital Services</th>
<th>Distance</th>
<th>Other priorities</th>
<th>Time</th>
<th>Ridicule</th>
<th>Destiny</th>
<th>Age</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freq family &lt; US$2/day (%)</td>
<td>42 (17.6)</td>
<td>22 (9.2)</td>
<td>147 (61.5)</td>
<td>25 (10.5)</td>
<td>68 (28.5)</td>
<td>36 (15.1)</td>
<td>45 (18.8)</td>
<td>3 (1.3)</td>
<td>12 (5)</td>
<td>39 (16.3)</td>
<td>15 (6.3)</td>
</tr>
<tr>
<td>Freq family &gt; US$2/day (%)</td>
<td>6 (7.9)</td>
<td>5 (6.6)</td>
<td>43 (56.6)</td>
<td>18 (23.7)</td>
<td>6 (7.9)</td>
<td>13 (17.1)</td>
<td>10 (13.2)</td>
<td>0 (0)</td>
<td>2 (2.6)</td>
<td>13 (17.1)</td>
<td>7 (9.2)</td>
</tr>
<tr>
<td>chi squared P</td>
<td>0.041</td>
<td>0.476</td>
<td>0.444</td>
<td><strong>0.003</strong></td>
<td>&lt;0.001</td>
<td>0.669</td>
<td>0.257</td>
<td>0.326</td>
<td>0.379</td>
<td>0.872</td>
<td>0.382</td>
</tr>
<tr>
<td>OR (95% CI) family &gt; US$2/day / &lt; US$2/day</td>
<td><strong>0.402 (0.164 - 0.987)</strong></td>
<td>0.695 (0.254 - 1.902)</td>
<td>0.816 (0.483 - 1.376)</td>
<td><strong>2.657 (1.357 - 5.201)</strong></td>
<td><strong>0.216 (0.089 - 0.520)</strong></td>
<td>1.164 (0.581 - 2.330)</td>
<td>0.653 (0.312 - 1.369)</td>
<td>-</td>
<td>0.511 (0.112 - 2.337)</td>
<td>1.058 (0.532 - 2.107)</td>
<td>0.515 (0.594 - 3.866)</td>
</tr>
</tbody>
</table>
### g) Age

<table>
<thead>
<tr>
<th>Age</th>
<th>Not aware</th>
<th>Lack of felt need</th>
<th>Cost</th>
<th>Hospital Services</th>
<th>Distance</th>
<th>Other priorities</th>
<th>Time</th>
<th>Ridicule</th>
<th>Destiny</th>
<th>Age</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nptrend</td>
<td>0.218</td>
<td>1</td>
<td>0.004</td>
<td>0.017</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>0.453</td>
<td>0.186</td>
<td>0.185</td>
<td>&lt;0.001</td>
<td>0.131</td>
</tr>
<tr>
<td>15-29</td>
<td>0.91(0.40-2.10)</td>
<td>1</td>
<td>1</td>
<td>1.34(0.73-2.44)</td>
<td>0.92(0.3-8.23)</td>
<td>1</td>
<td>1.05(0.37-3.03)</td>
<td>1</td>
<td>0.78(0.10-6.15)</td>
<td>1</td>
<td>1.12(0.15-8.58)</td>
</tr>
<tr>
<td>30-49</td>
<td>0.76(0.32-1.82)</td>
<td>0.84(0.41-1.73)</td>
<td>0.67(0.22-2.07)</td>
<td>1.52(0.6-2.37)</td>
<td>0.76(0.09-6.66)</td>
<td>0.18(0.13-0.78)</td>
<td>1.42(0.48-4.21)</td>
<td>-</td>
<td>1.55(0.19-12.37)</td>
<td>-</td>
<td>4.62(0.61-34.77)</td>
</tr>
<tr>
<td>50-69</td>
<td>0.54(0.13-2.26)</td>
<td>0.18(0.04-0.85)</td>
<td>1.88(1.01-3.52)</td>
<td>1.4(0.32-6.05)</td>
<td>4.13(1.3-7.12.43)</td>
<td>-</td>
<td>0.66(0.113-3.81)</td>
<td>-</td>
<td>1.36(0.08-22.60)</td>
<td>-</td>
<td>9.64(1.0.10-84.37)</td>
</tr>
<tr>
<td>70+</td>
<td>2.10(0.85-5.19)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

**Abbreviations** – Freq = Frequency, M = Male, F = Female, U = Urban, R = Rural, NSE=No Secondary Education, ALSE=At Least Secondary Education, NVI = Near Visual Impairment, DVI = Distance Visual Impairment, P = P value chi sq, OR = odds ratio value, CI =confidence interval

NB. Value emboldened where statistically significant and age is in years

Multivariate analysis using logistic regression was employed to establish the adjusted odds ratios for the following explanatory variables controlling for potential confounding; location, education, collective family income and age. Models considered are shown in Table 10. After adjusting for education, income and age, participants residing in rural areas were 6.03 (2.71-13.42) times more likely to report distance as a barrier. However, participants residing in the rural areas were 0.44 (0.24-0.82) times less likely to report time as a barrier. The remaining results in Table 10 show insignificant results or significant results within the confidence intervals of the previous results stated in Table 13.
Table 1 - Logistic regression

<table>
<thead>
<tr>
<th>Variable</th>
<th>Not aware</th>
<th>Lack of felt need</th>
<th>Cost</th>
<th>Hospital services</th>
<th>Distance</th>
<th>Other priorities</th>
<th>Time</th>
<th>Ridicule</th>
<th>Destiny</th>
<th>Age</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location *</td>
<td>0.67</td>
<td>1.46</td>
<td>0.93</td>
<td>1.01</td>
<td>6.03</td>
<td>0.82</td>
<td>0.44</td>
<td>0.25</td>
<td>1.01</td>
<td>0.78</td>
<td>1.02</td>
</tr>
<tr>
<td>(0.35 - 1.29)</td>
<td>(0.59 - 3.63)</td>
<td>(0.58 - 1.52)</td>
<td>(0.51 - 2.01)</td>
<td>(2.71 - 13.42)</td>
<td>(0.43 - 1.58)</td>
<td>(0.24 - 0.82)</td>
<td>(0.02 - 2.86)</td>
<td>(0.31 - 3.24)</td>
<td>(0.42 - 1.46)</td>
<td>(0.41 - 2.57)</td>
<td></td>
</tr>
<tr>
<td>Education *</td>
<td>1.14</td>
<td>0.39</td>
<td>0.75</td>
<td>1.14</td>
<td>1.94</td>
<td>1.37</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
<td>1.74</td>
<td>0.79</td>
</tr>
<tr>
<td>(0.35 - 3.70)</td>
<td>(0.05 - 3.18)</td>
<td>(0.33 - 1.67)</td>
<td>(0.41 - 3.18)</td>
<td>(-)</td>
<td>(0.73 - 5.17)</td>
<td>(0.50 - 3.80)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
<td>(0.66 - 4.59)</td>
<td>(0.16 - 3.80)</td>
</tr>
<tr>
<td>Income family *</td>
<td>0.33</td>
<td>0.85</td>
<td>0.87</td>
<td>2.62</td>
<td>0.49</td>
<td>1.08</td>
<td>0.43</td>
<td>0.43</td>
<td>0.63</td>
<td>0.92</td>
<td>1.63</td>
</tr>
<tr>
<td>(0.13 - 0.85)</td>
<td>(0.28 - 2.55)</td>
<td>(0.49 - 1.55)</td>
<td>(0.24 - 1.26)</td>
<td>(1.25 - 5.50)</td>
<td>(0.19 - 2.33)</td>
<td>(0.19 - 0.97)</td>
<td>(-)</td>
<td>(0.13 - 3.06)</td>
<td>(0.43 - 1.96)</td>
<td>(0.59 - 4.51)</td>
<td></td>
</tr>
<tr>
<td>Age2 *</td>
<td>1.50</td>
<td>2.35</td>
<td>0.90</td>
<td>0.50</td>
<td>1.01</td>
<td>0.49</td>
<td>1.36</td>
<td>0.16</td>
<td>0.74</td>
<td>2.74</td>
<td>0.39</td>
</tr>
<tr>
<td>(0.31 - 7.23)</td>
<td>(0.50 - 11.16)</td>
<td>(0.32 - 2.54)</td>
<td>(0.14 - 1.76)</td>
<td>(0.24 - 4.24)</td>
<td>(0.19 - 1.30)</td>
<td>(0.35 - 5.24)</td>
<td>(0.01 - 2.88)</td>
<td>(0.08 - 6.84)</td>
<td>(0.34 - 22.11)</td>
<td>(0.07 - 2.13)</td>
<td></td>
</tr>
<tr>
<td>Age3</td>
<td>1.60</td>
<td>1.43</td>
<td>1.15</td>
<td>0.47</td>
<td>1.27</td>
<td>0.57</td>
<td>0.96</td>
<td>0.12</td>
<td>0.78</td>
<td>3.97</td>
<td>0.75</td>
</tr>
<tr>
<td>(0.34 - 7.54)</td>
<td>(0.30 - 6.82)</td>
<td>(0.41 - 3.22)</td>
<td>(0.13 - 1.62)</td>
<td>(0.31 - 5.14)</td>
<td>(0.23 - 1.44)</td>
<td>(0.25 - 3.66)</td>
<td>(0.01 - 2.14)</td>
<td>(0.09 - 6.83)</td>
<td>(0.50 - 31.30)</td>
<td>(0.15 - 3.64)</td>
<td></td>
</tr>
<tr>
<td>Age4</td>
<td>0.68</td>
<td>1.09</td>
<td>0.51</td>
<td>2.00</td>
<td>0.29</td>
<td>0.42</td>
<td>3.68</td>
<td>0.24</td>
<td>3.68</td>
<td>0.40</td>
<td>0.24</td>
</tr>
<tr>
<td>(-)</td>
<td>(-)</td>
<td>(0.33 - 3.59)</td>
<td>(0.43 - 9.24)</td>
<td>(-)</td>
<td>(0.04 - 1.98)</td>
<td>(-)</td>
<td>(0.02 - 7.24)</td>
<td>(0.40 - 33.64)</td>
<td>(0.02 - 2.88)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Categorised as (baseline) ‘Urban’ and ‘Rural’

Categorised as (baseline) ‘No Secondary Education’ and ‘At Least Secondary Education’

Categorised as family income ‘< US$2/day’ (baseline) and '> US$2/day’

Categorised as age1= 15-29 (baseline); age2=30-49; age3=50-69; age4=70+ years
6.4 Discussion

The results of this study provide a clear indication that the perceived cost of spectacles and spectacle services comprises the most substantial barrier to uptake of refractive services in Nampula. Neither gender, location nor VI type had a significant impact on who selected cost as a barrier, suggesting that positive responses for cost came from participants from a variety of situations and backgrounds. These findings are in general agreement with the existing body of evidence that identifies cost or affordability as the major barrier to uptake of eye health services (Marmamula et al 2011, Kuper et al 2008, Laviers et al 2011, Ramke et al 2007). The personal and family financial situations of participants were found not to have an association with cost being stated as a barrier, indicating it is perceived as a barrier to both advantaged and disadvantaged families. However, wealth may be relative and should be considered in context. For example, a family considered advantaged in Mozambique, may not be considered advantaged in neighbouring South Africa.

Participants with either a personal income or a combined family income of more than US$2 per day were found to be more likely to report adequacy of hospital services compared to those with a personal income of less than this value. This may reflect their desire to get value for the resources they may allocate to improving their vision. Participants who have less resources may be relying on charity to cover their medical costs, and so feel less entitled to a good quality service. Participants with a personal income or a combined family income of more than US$2 per day were also found to be less likely to report the distance to a service facility as a barrier, perhaps explained by their means to pay for transport.

For refractive services in Mozambique to be fully equitable, they should be available to everyone, regardless of their ability to pay. A policy may be needed to ensure the most
vulnerable members of society can, for example, access subsidised care. A cross subsidisation system would allow funds generated through provision of services to wealthier patients to facilitate refractive services to the poor. The Aravind Eye Care System in India has successfully adopted this approach for many years (Lindfield & Foster 2008). More research is needed to establish if a similar system would be suitable for implementation in the Mozambican context bearing in mind that the health system is more government focussed in Mozambique. This creates policy and political challenges whereby governments are averse to income generation strategies. It is clear that careful planning as well as innovative thinking is needed if the barrier of cost is to be overcome. The value of social entrepreneurial models have been described in other low income settings and can result in the expansion of services and poverty reduction (Naidoo & Jaggernath 2012). Such strategies that seek to mobilise optometrists through an ownership program with affordability restrictions on pricing, should be investigated.

Refractive error was selected as a VISION 2020 priority condition, not just because of the burden of VI that it represents, but also because of how easily and affordably it can be treated (Holden & Resnikoff 2002). Readymade spectacles are suitable for correcting a significant proportion of refractive errors, most notably presbyopia. With readymade spectacle now being available for a few dollars per unit, cost should become less of a barrier (Ramke et al 2007). This is particularly pertinent for the most vulnerable groups in any society.

Affordability must be considered, however, as well as cost. Affordability depends as much on the cost of preserving sight as it does on the degree the patient prizes their sight and the ability for it to be paid for (Sommer 1995). The WTP analysis, which is described in the next chapter, will provide a greater understanding of affordability for refractive services in Mozambique.
In all countries and contexts, eye health costs money. Where possible, eye health services should be able to stand alone in terms of covering expenditure. There is the potential for the burden of URE to be vastly reduced or eliminated by developing self-sustainable systems including for human resources development and delivery of spectacles (Holden et al 2000). If the returns on the service provided do not cover the costs there is reason for concern (Smith 1995). In the long term, stability can only be guaranteed through high indigenous local demand (Sommer 1995). The more people that benefit from a service, the more likely it is to be cost-effective (Baltussen et al 2004).

Efficient use of resources can also impact on affordability. The refractive service offered should be of the best possible quality. Improving quality may involve initial investment, but will save money in the long term. Many improvements can come at low or no cost, such as a change in standard operating procedures for the eye health team to make the service they provide more efficient. Although this study found that the adequacy of refractive services was only stated as a barrier by 4% of participants, offering poor quality services is a waste of resources. It may also damage future or repeat uptake of the services on offer, and may fail to deliver on the opportunity to eliminate cases of avoidable blindness (Lindfield & Foster 2008). Strong leadership and good management, including the use of best practice business techniques will be essential to the success of the refractive service system (Smith & Smith 1996, Rahmathullah et al 2007, Taylor et al 2007). Further research and planning is needed to understand and maximise the benefits of the establishment of a professional board of optometry, clinical competency framework and regulatory body for the fledgling profession of optometry in Mozambique.

The high proportion of individuals citing lack of felt need as a perceived barrier suggests that investment to address the health promotion issues associated with eye health and to highlight the
benefits of addressing refractive error would seem prudent. The findings also suggest that the health promotion needs are particularly important among those with near VI, who appear more likely, compared to those with distance VI, to suggest a lack of felt need. Such a difference might be explained, at least in part, by the possibility that near VI may create a less severe impact on functionality or participation in everyday life, and may also be grounded in the belief that such visual loss is a normal aspect of aging. While improving the vision of patients suffering URE is likely to improve their lives, the lack of felt need suggests that outcomes of refractive services may be less dramatic than the outcomes of other eye health interventions, such as cataract surgery. However, as several studies have shown, the impact of correcting refractive error on productivity makes it a worthwhile intervention (Frick & Foster 2003, Frick et al 2005, Smith et al 2009). Increased advocacy and education can serve to maximise the societal benefit achieved. The finding that people from rural locations perceived themselves to be disadvantaged by the distance and adequacy of hospital services was predictable given that eye health services are mostly centred in urban locations. Poor infrastructure and limited transport options exacerbate the problem. The necessity to provide dedicated refractive services to all rural populations who live outside the urban catchment area of health and social services provides a challenge (Dandona & Dandona 2001 a, Kovai et al 2007, Ho & Schwab 2001). This is particularly pertinent to Mozambique, where limited financial and material resources reduce the ability of the people living rurally to get the eye care they need. It is also possible that rural dwellers felt they would be discriminated against if they accessed urban based services, on the grounds of where they live. More research is needed on the impact of the rural/urban cultural divide, and how location may negatively influence access to services. For a service to be universal, all patients must be treated appropriately and equally. If the
VISION 2020 objective of eliminating avoidable blindness by the year 2020 is to be met, the distribution of refractive services within Mozambique must take into account the needs of those in rural areas.

Significantly more rural participants were also more likely to state they were unaware they had a problem than urban participants, suggesting eye health promotion efforts in rural areas need to be strengthened. Also, significantly more rural participants stated the perception that VI for old age is untreatable or destiny/God’s will as being barriers - possibly explained by those living in rural areas generally having more traditional views and less education than those in urban areas. These barriers, along with fear of eyesight getting worse if treated and/or a family member restricting access may be associated with entrenched cultural traditions or a lack of information about eye health services. Fear of ridicule also falls into this bracket, although anecdotal evidence from Mozambique suggests many people regard wearing spectacles as a mark of prosperity, resulting in people wearing them to boost their status in society, even if they do not really need them.

Cultural or belief based barriers of this sort have been described in other studies as ‘difficult to change’, as they may require a sustained long-term effort both by the individual, communities and the service provided to overcome the challenge (Marmamula et al 2011). The results indicate that in Nampula, despite these barriers being more commonly identified with by people in rural areas, in the wider context these are not the most pressing barriers to uptake of refractive services. Collectively, these five barriers were only selected by 10% of participants. This indicates that Mozambican society (or at least those people residing in Nampula) would have limited social or cultural reservations to utilising refractive services, were they accessible. This is encouraging, particularly when considered alongside the finding that there was not a strong association between gender in Mozambique and stated barriers, as it suggests that Mozambican
society has relatively progressive views on correcting refractive error and wearing spectacles when they are needed. It should be noted that it was found that females were 0.34 times less likely to report destiny as a barrier compared to males, although the proportions of positive responses were relatively low.

Elderly patients were found to be more likely to report distance as a barrier, compared to younger participants. As people get older their mobility may be reduced, making them less able to travel to health facilities. The needs of the elderly will need to be considered when planning eye health services and the decentralisation of refractive services needs to be explored. The relative flexibility and ease of setting up refraction services make this a viable strategy.

Participants without a formal secondary school education were found to be more likely to be unaware of the problem and more concerned with cost. This is understandable on the basis that they are potentially less likely to understand about eye health and their income would likely be lower than those who are educated. However, as shown above, income did not appear to impact on cost being selected as a barrier. More research is needed to explore this relationship. Those without secondary education were also found to be less likely to report distance as a barrier. This relationship may be linked to their increased likelihood of being unaware of the problem.

The RARE for Mozambique found that URE prevalence was 2.6% (95% CI 2.1%-3.2%), with spectacle coverage of 0%. Presbyopia prevalence was 25.8% (95% CI 12.0% - 30.5%), with only 2.2% spectacle coverage (Loughman et al 2014). By way of comparison, the RARE study in Eritrea found URE prevalence was 6.4% (95% CI 5.6%-7.2%) and spectacle coverage of 22.2%, while for presbyopia prevalence was 32.9% (95% CI 30.3%-35.7%) with spectacle coverage of 9.9% (Chan et al 2013). Comparing RARE results magnifies how inaccessible refractive error
services are in Mozambique compared to Eritrea. Spectacle coverage is low and the results of this current study suggest that cost is the main barrier to explain why this is the case.

In 2011, a Rapid Assessment of Avoidable Blindness (RAAB) study was completed in Nampula Province. RAAB is a relatively simple, cheap and rapid survey methodology to provide data on avoidable blindness. It includes assessing the VA people who are 50 years of age and older, where prevalence of blindness is the highest. The RAAB study included an analysis of the barriers to cataract surgery. The cost of transport was found to present a significant challenge, accounting for 75% of all barriers stated. Other barriers included lack of awareness on possibility of treatment (9.9%) and believing that blindness is an irreversible result of aging (5.9%) (Kimani 2011). Despite differing methodologies, like the current study, the RAAB found that people in Nampula stated cost is the most significant barrier preventing them from accessing required eye health services. However, results from A RAAB study completed in 2014 in Sofala Province in central Mozambique, found that participants being unaware that treatment is possible for cataracts was the most frequently stated barrier (Bedri 2014). This was stated by over 35% of females and over 25% of males. Cost of surgery was only stated by under 5% of females and by no males. The comparison of data from the Nampula RAAB and the Sofala RAAB suggests there may be regional variations in access to eye health services. Further research is needed to explore these variations.

In hindsight, the methodology of the current study would have been made more robust if the participants had been asked to rank their selected barrier choices. 455 out of 1,087 participants selected two or more barriers. Applying a ranking system to the responses of these participants would have allowed a deeper analysis of the barriers to uptake of refractive services.
6.5 Conclusion

Cost and affordability are the most significant barriers to uptake of refractive services in Mozambique, comprising over 35% of all responses and identified by more than half of all participants. The RARE study conducted in tandem with this investigation confirms that the barriers to spectacle services are currently not just perceived, but very real in Mozambique. A spectacle coverage rate of 0% for URE and 2.2% for presbyopia compares very unfavourably with observations in other sub-Saharan countries, and highlights the inaccessibility of refractive services in the Nampula Province, which are likely reflective of the broader situation in Mozambique (and potentially Lusophone Africa). A greater understanding of attitudes towards cost and affordability of refractive services is needed. The results from this study on the barriers to refractive services uptake, along with the prevalence data from the Mozambican RARE will be critical to the national planning of refractive error services.
Chapter 7. Willingness to Pay for refractive error correction in Mozambique

7.1 Introduction

Mozambique has a population of over 25 million people (World Bank 2014a). The burden of URE in Mozambique is known to be high. A RARE in Nampula, Mozambique found that the provenance of URE to be 2.6% (95% CI 2.1%-3.2%). URE was found to be the primary cause of vision impairment (64.5% of cases). Spectacle coverage to address URE was 0%. Presbyopia prevalence was 25.8% (95% CI 12.0% - 30.5%), with 2.2% spectacle coverage (Loughman et al 2014). Spectacle coverage rates are low. To counter this burden, the MEP supported a higher education programme to train professional optometrists – the first of their kind in Lusophone Africa. This action complemented VISION 2020 core strategies, which include a focus on human resource development and infrastructure development (WHO 2010a). The first graduates completed the optometry course at Universidade Lúrio, in 2013 and began work for the public health system.

As indicated in the previous chapter, a study into barriers to refractive service utilisation in Mozambique found that cost was the barrier most frequently stated, being identified 579 times out of 1,631 responses (35.52%). 53% of participants felt cost was a barrier (Thompson et al 2015). This finding, combined with known low spectacle coverage in Mozambique, suggest that to reduce the burden on URE, it should be a priority to construct a sustainable system that is responsive to the financial and other needs of Mozambicans. To assist with the establishment of such a system, this current study aims to gain an understanding of the WTP for refractive
services by Mozambicans. This type of analysis can assist in policy decisions regarding the appropriate pricing of eye health services.

WTP methodology was first developed for the environmental sector (Davis 1963). It has since been adapted for many other sectors, including health. WTP is a methodology that can be used to measure health outcomes in monetary units by eliciting the maximum amount a person is willing to pay to receive a given outcome. The logic of WTP is that a person will assess all possible advantages and disadvantages (monetary or non-monetary) of an intervention or product and derive a monetary figure that represents their measure of value for the product in question (Maxwell et al 2008). The theoretical foundation of WTP is based on consumer demand theory (Bala et al 1999). It establishes the maximum amount of resources that a person would be willing to give up so that the person receiving the service considers him/herself to be just as well off with fewer resources as they would have been forgoing the service and retaining their resources (Frick & Baruwa 2007).

While many WTP methodologies exist and numerous studies have applied them to many health contexts, the first identified instance of WTP being used to assess perceived value of spectacles in a low income setting was in a study in Timor-Leste (Ramke et al 2007). The results of this study found that the majority of participants were unwilling to pay $1 for spectacles. Women and rural dwellers were identified as being less likely to be willing to pay at least $1 for spectacles. The need for spectacles was found to be greatest among people who had the least resources to pay for them. An equitable cross-subsidisation spectacle system was recommended to address this.

Key methodological features of WTP studies that need to be incorporated into the current study were identified from the existing body of evidence. O’Brien & Gafni (1996) advise that studies
undertaking contingent valuation should distinguish between compensating variation and
equivalent variation, and recognise that respondents can be gainers or losers in utility. As no
direct negative effects of the intervention can be identified this study will seek to identify a WTP
value, rather than willingness to accept value.

To make a study reliable, the interviews should be done face to face (Olsen & Smith 2001).
Diener et al (1998) state that it must be very clear and explicit which methods are being
employed and what exactly is being measured. The results must indicate what the author claims
they do. This includes being clear on a number of points including, 1) What questions do we
want to answer? 2) What type of measure can we use? 3) What do we need to ask of whom? 4)
What characteristics of the programme are important for determining how it is valued? 5) What
question formats minimise bias and increase precision (O’Brien & Gafni 1996).

Participants must be selected at random from the study area. Refractive error status will not
determine who is included or excluded. Diseased persons will in theory be represented in the
sample only in proportion to the prevalence of the disease in question (Labelle and Hurley 1992).
The participants must be adults must be asked not children, as children are rarely the financial
decision makers for the household (Congdon et al 2008). du Toit et al (2008) argues that the
matriarch of the household or the patriarch must respond to the questions. If it is anyone else,
they may struggle to reply in the context of the household budget.

In countries where prices are not fixed and negotiation for goods is standard practice, the bidding
format is preferred. This method is based on the notion of haggling – a process well understood
that may be employed during every day transactions. This method is particularly suitable for use
in developing countries (Donaldson et al (2006). Onwujekwe et al (2008) also argue that it is
possible to enhance the realism of contingent valuation method by using questions that mimic the
usual types of transactions to which participants are accustomed to. Using haggling techniques will allow participants to arrive at their true WTP value, allowing them to take the valuation more seriously. Lang et al (2012) contribute that the value of the starting bid can be determined through a pilot survey.

Hypothetical bias is a challenge when trying to establish WTP values. This refers to deviation in a WTP response from a valid response in a real market situation. It is the difference between stated WTP and actual WTP. Both Lang et al (2012) and Özdemira et al (2009) argue that to avoid hypothetical bias, a technique called cheap talk needs to be used. Cheap talk is where interviewers describe in as much detail as possible the hypothetical scenario, including the purpose of the study and that the study is hypothetical (the respondents will not be required to pay what they are WTP). The interviewer asks respondents to think very carefully about value, and compare their response to real items they may consume. The respondents are also told the importance of providing an accurate WTP response.

WTP responses can be need to be validated by evaluating whether WTP are associated with higher incomes. Wealth is a component of socio-economic status that is often estimated using material assets (Doocy & Burnham 2006). If income cannot be ascertained through direct questioning (possibly due to cultural or social sensitivity) income may be estimated by looking at proxy measures, such as vehicle or livestock ownership as appropriate.

WTP can also be validated by determining whether WTP increases with the additional increase in benefits. This also could be used to test for scope. Kartman et al (1996) argue that for the WTP study to be theoretically valid, it must demonstrate sensitivity to changes in scope. If participants respond negatively to questions designed to test their response to scope, then their original WTP value may not be reliable.
A third method of validation involves comparing WTP values with what consumers actually pay (Maxwell et al 2008). This third test was not possible for this study as permission was neither sought nor granted from the appropriate authorities to do this.

7.2 Methods

A community-based cross-sectional study was conducted using two stage cluster sampling. Clusters were defined by the administrative level of ‘Bairro’, meaning neighbourhood. There are 395 Bairros in Nampula Province (INE 2014). 19 Bairros were randomly selected for enumeration using a systematic random sampling method with probability proportional to size (PPS). A minimum of 60 participants were included per cluster. As the population of each bairro varies from under a hundred people to several thousand, if more time and resources were available, the number of people sampled from each cluster would correlate to the population of each bairro. Due to time and resource constraints, the calculation of sample size was based on several aspects including the required precision of the estimate and confidence levels. The sample of this study was set at a level to far exceed the necessary sample size required for the validation of the methodology. The sampling was conducted in a manner that each individual participating has the same participation weight and an equal probability of selection; therefore it is a self-weighting sample.

Participants were selected at random from the study area by means of door to door sampling. VI status (real or perceived) did not determine inclusion, on the basis that people with VI would be represented in the sample in proportion to the prevalence of VI (Labelle & Hurley 1992). The inclusion criteria was that participants needed to be at least 15 years of age, residing permanently at the address and actively involved in making financial decisions in the household. The
matriarch or the patriarch of the household were targeted as their responses were deemed to be more likely to be accurate in the context of the household budget (du Toit et al 2008). Those people found to not meet these criteria were excluded. Children were excluded as they are rarely the financial decision makers for the household or involved in expenditure. A WTP study in China was based on the responses of the children. The authors note that the responses may not represent the attitudes of parents making the actual expenditure (Congdon et al 2008). This logic can be applied to other countries and regions. For this reason, in the current study focused on Mozambique, only adults were invited to participate.

Participants completed a questionnaire by means of a face to face interview, to ensure protocol compliance and to improve accuracy of responses (Olsen & Smith 2001). The questionnaire was written in English, translated into Portuguese, and then translated back to English by an independent translator, to verify accuracy. Data collectors interviewed the participants in Portuguese or the regional language Makua, depending on which was more appropriate. Makua is branch of the Bantu languages. Although it is widely spoken in Nampula, it is rarely written down. If a participant was more comfortable responding in Makua, the data collectors were required to translate the responses into Portuguese.

The location of the dwelling of each participant was assessed by data collectors, based on household access to treated water and electricity supply, population density and the presence of surfaced roads. In 2011, 31.2% of total population was reported to live in rural areas (CIA 2014). Therefore A third of participants were selected from urban locations. The remaining two thirds of participants were selected from semi-rural and rural locations equally, equating to a third of participants coming from each location.
A series of background questions on demographics, financial situation and employment status were presented to participants. VA was assessed by either a qualified optometrist or by an optometry student enrolled at Universidade Lúrio, who had completed at least two years of study, and was under the supervision of a qualified optometrist. Patients were grouped according to accepted VI categories (Bourne et al. 2013). Questions were asked to establish any self-perceived problems with their vision. Participants were divided into those with or without VI (tested or perceived).

Prior to administrating the WTP section of the questionnaire, a technique called "cheap talk" was employed to prevent hypothetical bias (Lang et al 2012, Özdemira et al 2009). The following cheap talk statement was read to each participant:

"The purpose of this questionnaire is to gather data and gain an understanding of barriers to access of eye health services and what people are willing to pay for the services. We want your help to be able to make decisions on both of these topics. The questions on willingness to pay are hypothetical. Your response will be of vital information to us, but will not influence any outcomes that you will experience today. Before you respond to our questions, think carefully about both barriers to access and what you would be willing to pay for improvements to your eyesight. Pay a lot of attention to the options available to you. Consider what the prices mean to you or your family, or how it would impact on your monthly budget if you actually had to part with that money. If you do not pay attention to the actual costs, our analysis will be wrong. We won’t get a true measure of the value of eye health services. Please help us measure your preferences correctly by paying attention to the actual costs of eye health services before responding."
We ask for your help on a voluntary basis. You will not receive any payment for your contribution. You are free to refuse or to stop answering at any point.”

All participants, regardless of whether they had actual or perceived VI were then asked to imagine that their vision is failing due to URE. They were given a brief introduction to URE and informed how it may impact on their life in terms of limiting education, productivity and social interactions. They were informed that the problem could be solved by an optometrist providing a short, pain free examination – which does not involve surgery. The participant was informed a pair of spectacles (which would last for four years if well maintained) would resolve their VI.

WTP values were ascertained using two methods, a stated choice technique and a bidding game technique. While other WTP methodologies exist, stated choice technique and a bidding game were considered to be the most suitable for the context of this study. For the stated choice WTP value, each participant was simply asked what they would pay for the eye exam and the spectacles.

The bidding game format has been shown to be suitable for use in developing countries, as it is based on the notion of haggling and negotiation, mimicking the everyday transactions to which participants are accustomed to (Donaldson et al 2006, Onwujekwe et al 2008). To counter the risk of starting point bias, which bidding game methodology is potentially vulnerable to, participants were presented with one of four starting bids followed by pre-specified algorithms, as illustrated in Figure 23. The algorithms subjected all participants with the same starting bid to the same negotiation process (Frew et al 2006). Three bids were presented to each participant, each being determined by a positive or negative response to the bid before. Each participant had an equal opportunity to arrive at the same final value at the end of the bidding process, regardless
of the starting bid. At the end of the bidding process, the participant was asked if they were satisfied with the final bid, or if they were not, to confirm what their final bid would be.

Validation of WTP is usually done using three methodologies. Firstly participants are given an opportunity to actually pay for the service or product after stating a WTP value. This actual payment value is compared to the WTP value. The second methodology involves comparing WTP values to salaries. In general the more people earn the higher their WTP value is. Thirdly scope analysis investigates whether WTP values increase with additional benefits (Maxwell et al 2008). For this study, it was not practical to actually provide spectacles and full eye tests so the first validation methodology was not employed. However, the results were analysed, firstly in association to the respondent incomes and secondly in terms of scope.

For the first scope analysis question, participants were presented with the value that they had stated they would be willing to pay for an eye test and spectacles that would last four years. They were asked if they would be willing to pay half the amount for a pair that would last only two years. The second question asked the participant if they would pay double the higher value they had stated if a family member also needed an eye test and spectacles. The third question presented the participant with the option to have the additional benefit of varifocals, which would solve both their near and distance vision problems, but would cost them double their stated WTP.
Figure 23 – Algorithm options for WTP with differing starting points

(Abbreviations - Qn = Question number, Y = Yes (positive response), N = No (negative response))
The research followed the tenets of the Declaration of Helsinki. Informed consent was obtained from the subjects after explanation of the nature and possible consequences of the study. Approval was granted for the study by DIT’s ethics committee under the MEP and the Mozambican National Ethic Committee (Comité Nacional de Bioética para Saúde).

After training the data collectors, a pilot study was conducted. Responses from 60 participants (equivalent to >5% of the total participants expected to be enumerated) were recorded. The pilot revealed that the starting bids for the bidding game WTP methodology were too high when the financial situation of the pilot participants was considered (Lang et al 2012). The majority of families earned less than 2,000 Meticals a month. As such, WTP starting bids were set at 2,000 Meticals or below. Except for adjusting WTP starting bids to more suitable levels, no major changes to the questionnaire or protocol were identified at this stage. More detailed notes on lessons learned from the pilot study are included in the next chapter.

Figure 24 – Data collection for the WTP
7.3 Results

Data was collected on 1,144 participants. Four participants were found to be blind and were excluded from the analysis on the grounds that an eye test and spectacles would not improve their VA, thus invalidating WTP values given. Three participants started the interview, but did not want to answer questions on WTP and were excluded. In total 1,137 participants were included in the study. Of these, 381 (33.5%) were from urban areas, 351 (30.9%) from semi-urban areas, and 405 (35.6%) were from rural areas.

The median participant age was 34 years old (IQR: 25-48years), with a minimum age of 16 years and maximum age of 95 years. The median number of dependent children was 2 (IQR: 1-4). The maximum number of dependent children was 14. There were slightly more male participants than females, with 52.2% being male and 47.8% being female. 701 (61.07%) participants stated that they were literate, although 971 participants (85.4%) had no secondary school or tertiary education. Only 172 (15.1%) participants had formal employment, 767 participants (67.5%) were self-employed or informally employed, 170 (15%) had no work at all and 28 of them (2.5%) were retired. 883 participants (77.7%) earned less than 2,000 Meticals per month – just over $2 a day - on an individual basis and 767 of them (67.5%) had a combined family income of less than 2,000 Meticals per month. More details on participant characteristics are displayed in Table 14.

As shown in Table 15, in total, 803 participants (70.6%) were found to have no actual VI. 40 participants (3.5%) had mild VI, 80 participants (7%) had moderate VI, 18 participants (1.6%) had severe VI and 196 participants (17.2%) had near VI.
Table 14 - Participant characteristics

<table>
<thead>
<tr>
<th>Category</th>
<th>Characteristic</th>
<th>Frequency</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>Urban</td>
<td>381</td>
<td>33.5</td>
</tr>
<tr>
<td></td>
<td>Semi Urban</td>
<td>351</td>
<td>30.9</td>
</tr>
<tr>
<td></td>
<td>Rural</td>
<td>405</td>
<td>35.6</td>
</tr>
<tr>
<td>Gender</td>
<td>Male</td>
<td>593</td>
<td>52.2</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>544</td>
<td>47.8</td>
</tr>
<tr>
<td>Stated literacy</td>
<td>Literate</td>
<td>701</td>
<td>61.7</td>
</tr>
<tr>
<td></td>
<td>Illiterate</td>
<td>436</td>
<td>38.3</td>
</tr>
<tr>
<td>Level of schooling</td>
<td>No secondary school</td>
<td>971</td>
<td>85.4</td>
</tr>
<tr>
<td></td>
<td>Secondary school</td>
<td>135</td>
<td>11.9</td>
</tr>
<tr>
<td></td>
<td>Degree</td>
<td>31</td>
<td>2.7</td>
</tr>
<tr>
<td>Employment status</td>
<td>Employed</td>
<td>172</td>
<td>15.1</td>
</tr>
<tr>
<td></td>
<td>Self employed</td>
<td>767</td>
<td>67.5</td>
</tr>
<tr>
<td></td>
<td>Unemployed</td>
<td>170</td>
<td>15.0</td>
</tr>
<tr>
<td></td>
<td>Retired</td>
<td>28</td>
<td>2.5</td>
</tr>
<tr>
<td>Personal income per month</td>
<td>0 - &lt;2k Meticals</td>
<td>883</td>
<td>77.7</td>
</tr>
<tr>
<td></td>
<td>&gt;2k Meticals</td>
<td>254</td>
<td>22.3</td>
</tr>
<tr>
<td>Family income per month</td>
<td>0 - &lt;2k Meticals</td>
<td>767</td>
<td>67.5</td>
</tr>
<tr>
<td></td>
<td>&gt;2k Meticals</td>
<td>370</td>
<td>32.5</td>
</tr>
</tbody>
</table>

Abbreviations: Meticals = Mozambican Meticals (US$1 = 30 Meticals) Oanda 2014
Table 15 – Actual vision loss (Bourne et al 2013)

<table>
<thead>
<tr>
<th>Vision loss category</th>
<th>Definition by visual acuity* in the better eye</th>
<th>Frequency</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>No VI</td>
<td>No identified visual problems</td>
<td>803</td>
<td>70.6</td>
</tr>
<tr>
<td>Mild VI</td>
<td>&lt;6/12 but ≥6/18</td>
<td>40</td>
<td>3.5</td>
</tr>
<tr>
<td>Moderate VI</td>
<td>&lt;6/18 but ≥6/60</td>
<td>80</td>
<td>7</td>
</tr>
<tr>
<td>Severe VI</td>
<td>&lt;6/60 but ≥3/60</td>
<td>18</td>
<td>1.6</td>
</tr>
<tr>
<td>Near VI</td>
<td>&lt;6/12 but ≥3/60 for near, but ≥6/12 for distance</td>
<td>196</td>
<td>17.2</td>
</tr>
</tbody>
</table>

* Snellen VA or the equivalent calculated from published LogMAR values.

315 participants (27.7%) had actual VI and were aware they had a problem. Only 19 participants (1.7%) had actual VI and were unaware of the problem. 348 participants (30.6%) perceived they had VI, although the VA test indicated they did not. A total of 455 participants (40%) had no actual or perceived VI.

In total 665 participants (58.5%) had actual or perceived VI. Of these, 286 participants (43%) stated that they knew where to get their eyes tested and 578 of them (86.9%) did not have spectacles. One participant with no actual or perceived VI responded that they had spectacles. Of the 87 participants with spectacles, 76 of them provided information on how much they cost. The mean cost was 645.20 Meticals (SD. 1399.723) ($21.29). Some people got them for free. The maximum price that was paid was 8,000 Meticals ($264.03).

A general trend was observed whereby the stated choice WTP value was similar to the final bid WTP value. As illustrated in Figure 25, for 334 participants, the variance between the two WTP
values was zero. For 302 participants, their stated WTP value was greater than their final bid. For the remaining 501 participants, their final bid was greater than their stated choice WTP value. However, for a third of these participants, the final bid was less than 100 Meticals greater than their stated choice value. The greatest variation was 4,800 Meticals between the final bid and the stated choice.

![Graph](image)

**Figure 25 – Variation between the responses for the two methodologies**

Only 71 participants provided data on where they sourced their spectacles. 35 people (49.3%) had bought them on the street, 13 people (18.3%) had received them through the MEP, 10 people (14.1%) had received them through the hospital and 7 people (9.9%) had got them through an optician (known locally as optishop). The remainder were sourced from church, as a gift, borrowed, from the capital or abroad.
The mean stated WTP value was 388.92 Meticals (SD. 602.092) ($12.84). The mean final bid WTP value was 469.89 Meticals (SD. 666.240) ($15.51).

The mean stated WTP and final bid WTP values and standard deviations for several variables are displayed in Table 16. Effect size was calculated using an effect size calculator (UCCS 2014).

A Spearman's rank correlation test was used to assess the relationship between WTP and the variables of age and price paid for spectacles. The results indicated that there was a weak and non-significant relationship between age on stated WTP (rho=-0.042; p = 0.155) or the final bid WTP (rho=-0.039; p = 0.193). Although only 76 participants had previously had spectacles, it was found that there was a positive monotonic relationship between the cost of previous spectacles and both stated WTP (rho=0.472; p = < 0.01) and the bidding game WTP (rho=0.302; p= 0.007).

Independent sample T tests were used to analyse the variables of gender, spectacle ownership, personal income, and family income. The mean stated WTP value for males was significantly higher compared to females (p=0.001). Similarly, the mean final bid WTP value for males was significantly higher than that of females (p<0.01). Participants with spectacles were found to have a higher mean for stated WTP (p=0.002), as well as a significantly higher final WTP bid (p=0.002) compared to participants without spectacles.

Participants with a personal income of less than 2,000 Meticals had a significantly lower mean stated WTP (p<0.001), as well as a significantly lower mean WTP final bid (p<0.001), compared to participants with an income of more than 2,000 Meticals. Participants with a family income of less than 2,000 Meticals had a significantly lower mean for stated WTP (p<0.01) and a significantly lower mean for WTP final bid (p<0.01), compared to participants with a family income of more than 2,000 Meticals.
### Table 16 – Means, Standard Deviations and effect size

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Variable</th>
<th>Stated WTP Mean (SD)</th>
<th>Final bid WTP Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>440.69 (594.843)</td>
<td>543.68 (703.448)</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>332.50 (605.414)</td>
<td>389.47 (613.762)</td>
</tr>
<tr>
<td></td>
<td>Cohen’s D (effect size)</td>
<td>0.180</td>
<td>0.234</td>
</tr>
<tr>
<td><strong>Spectacle ownership</strong></td>
<td>Has spectacles</td>
<td>670.00 (979.962)</td>
<td>779.89 (1069.218)</td>
</tr>
<tr>
<td></td>
<td>No spectacles</td>
<td>365.64 (553.854)</td>
<td>444.21 (615.088)</td>
</tr>
<tr>
<td></td>
<td>Cohen’s D (effect size)</td>
<td>0.382</td>
<td>0.385</td>
</tr>
<tr>
<td><strong>Personal income</strong></td>
<td>&lt;2k Meticals/m</td>
<td>293.33 (457.893)</td>
<td>346.31 (478.302)</td>
</tr>
<tr>
<td></td>
<td>&gt;2k Meticals/m</td>
<td>721.26 (868.345)</td>
<td>899.53 (978.208)</td>
</tr>
<tr>
<td></td>
<td>Cohen’s D (effect size)</td>
<td>-0.616</td>
<td>-0.719</td>
</tr>
<tr>
<td><strong>Family income</strong></td>
<td>&lt;2k Meticals/m</td>
<td>266.40 (437.965)</td>
<td>307.72 (434.976)</td>
</tr>
<tr>
<td></td>
<td>&gt;2k Meticals/m</td>
<td>642.92 (788.644)</td>
<td>806.08 (897.634)</td>
</tr>
<tr>
<td></td>
<td>Cohen’s D (effect size)</td>
<td>-0.590</td>
<td>-0.707</td>
</tr>
<tr>
<td><strong>Location</strong></td>
<td>Urban</td>
<td>522.78 (763.712)</td>
<td>612.61 (772.412)</td>
</tr>
<tr>
<td></td>
<td>Semi urban</td>
<td>392.09 (578.835)</td>
<td>488.28 (639.124)</td>
</tr>
<tr>
<td></td>
<td>Rural</td>
<td>260.25 (383.368)</td>
<td>319.70 (539.399)</td>
</tr>
<tr>
<td><strong>Employment status</strong></td>
<td>Employed</td>
<td>819.80 (1075.468)</td>
<td>961.45 (1044.054)</td>
</tr>
<tr>
<td></td>
<td>Self employed</td>
<td>291.70 (394.532)</td>
<td>354.15 (493.166)</td>
</tr>
<tr>
<td></td>
<td>Unemployed</td>
<td>388.71 (547.439)</td>
<td>497.88 (662.902)</td>
</tr>
<tr>
<td></td>
<td>Retired</td>
<td>406.61 (428.723)</td>
<td>451.07 (442.981)</td>
</tr>
<tr>
<td><strong>Education</strong></td>
<td>No secondary</td>
<td>311.29 (426.181)</td>
<td>381.40 (500.905)</td>
</tr>
<tr>
<td></td>
<td>Secondary school</td>
<td>660.70 (856.344)</td>
<td>773.19 (872.630)</td>
</tr>
<tr>
<td></td>
<td>Degree</td>
<td>1637.10 (1562.582)</td>
<td>1920.97 (1565.555)</td>
</tr>
<tr>
<td><strong>VI category</strong></td>
<td>No VI</td>
<td>405.85 (607.300)</td>
<td>491.33 (666.268)</td>
</tr>
<tr>
<td></td>
<td>Mild VI</td>
<td>481.50 (536.874)</td>
<td>578.50 (760.356)</td>
</tr>
<tr>
<td></td>
<td>Moderate VI</td>
<td>297.75 (456.962)</td>
<td>391.50 (528.738)</td>
</tr>
<tr>
<td></td>
<td>Severe VI</td>
<td>288.06 (433.716)</td>
<td>255.00 (358.563)</td>
</tr>
<tr>
<td></td>
<td>Near VI</td>
<td>347.17 (653.710)</td>
<td>411.63 (710.998)</td>
</tr>
<tr>
<td><strong>VI status</strong></td>
<td>Actual and perceived</td>
<td>355.79 (601.345)</td>
<td>429.21 (680.459)</td>
</tr>
<tr>
<td></td>
<td>Actual but not perceived</td>
<td>222.89 (277.055)</td>
<td>238.42 (226.747)</td>
</tr>
<tr>
<td></td>
<td>Perceived but not actual</td>
<td>454.90 (624.798)</td>
<td>547.64 (669.924)</td>
</tr>
<tr>
<td></td>
<td>No actual or perceived</td>
<td>368.33 (591.517)</td>
<td>448.26 (660.960)</td>
</tr>
</tbody>
</table>
One way ANOVA tests were used to analyse the association between WTP and the variables of location, employment status, and education. For each variable the assumption of homogeneity of variance was violated; therefore the Welch F-ratio is reported, followed by a Games Howell Post Hoc test.

There was a statistically significant relationship between the stated means and location, $F (2, 675.287) = 20.840, p= < 0.001$. There is significant difference between the stated WTP value of urban and semi urban participants (mean difference = 130.69, $p = 0.024$), urban and rural participants (mean difference = 262.53, $p= < 0.001$), and semi urban and rural participants (mean difference = 131.84, $p= 0.001$).

There was also a statistically significant relationship between the final bid means and location, $F (2, 726.082) = 20.525, p= < 0.001$. There is significant difference between the final bid WTP value of urban and semi urban participants (mean difference = 124.34, $p = 0.046$), urban and rural participants (mean difference = 292.91, $P = < 0.001$), and semi urban and rural participants (mean difference = 168.57, $p = < 0.001$).

There was a statistically significant relationship between the stated WTP value means and employment status, $F (3, 109.860) = 14.782, p = < 0.001$. There is significant difference between the stated WTP value of employed and self-employed participants (mean difference =528.09, $p= < 0.001$), employed and unemployed participants (mean difference = 431.09, $p = < 0.001$), and employed and retired participants (mean difference =413.19, $p = 0.003$).

There was a statistically significant relationship between the final bid means and employment status, $F (3, 112.257) = 19.903, p = < 0.001$. There was a significant difference between the final bid WTP value of employed and self-employed participants (mean difference =607.31, $p= <
employed and unemployed participants (mean difference = 463.57, \( P = < 0.001 \)), employed and retired participants (mean difference = 510.38, \( p = < 0.001 \)), and unemployed and self-employed participants (mean difference = 143.74, \( P = < 0.041 \)).

There was a statistically significant differences between the stated WTP bid means and education level, \( F (2, 66.406) = 21.586, p = < 0.001 \). There is significant difference between the stated WTP value of participants with a degree and those with no secondary education (mean difference = 1325.81, \( p = < 0.001 \)), participants with a degree and those with a secondary education (mean difference = 976.39, \( P = 0.005 \)), and participants with a secondary education and those without a secondary education (mean difference = 349.41, \( p < 0.001 \)).

There was a statistically significant relationship between the final bid WTP value means and education level, \( F (2, 66.744) = 27.349, p = < 0.001 \). There is significant difference between the final bid WTP value of participants with a degree and those with no secondary education (mean difference = 1539.57, \( p < 0.001 \)), participants with a degree and those with a secondary education (mean difference = 1147.78, \( p = 0.001 \)), and participants with a secondary education and those without a secondary education (mean difference = 391.78, \( p < 0.001 \)).

One way ANOVA tests found there was no statistically significant difference between the stated WTP means and people with different levels of VI, \( F (4, 1132) = 1.217, p = 0.302 \), and no statistically significant differences between the final bid means and people with different levels of VI, \( F (4, 1132) = 1.597, p = 0.173 \).

One way ANOVA tests were used to analyse the relationship between WTP and VI status (actual or perceived. There was no statistically significant difference between the stated WTP means and VI status (actual or perceived) \( F (3, 1133) = 2.378, p = 0.068 \).
For the relationship between VI status (actual or perceived) and the final bid WTP value, the assumption of homogeneity of variance was violated; therefore the Welch $F$-ratio is reported, followed by a Games Howell Post Hoc test. A statistically significant relationship was found between the final bid WTP value means and VI status (actual or perceived) (Asymptotically $F$ distributed statistic $= 7.940, p < 0.001$). $F (3, 107.678) = 7.940, p < 0.001$.

There was a significant difference between the final bid WTP value of participants with actual and perceived VI and those with actual but not perceived VI (mean difference $= 190.79, p = 0.025$), participants with perceived but not actual VI and those with actual but not perceived VI (mean difference $= 309.22, P = < 0.001$), and participants with no actual or perceived VI and those with actual but not perceived VI (mean difference $= 209.84, p = 0.008$).

For the scope analysis 867 participants (76.3%) gave a positive response to two or more of the questions. The remaining 270 (23.7%) gave a negative response to two or more of the questions. The means for the scope analysis are displayed in Table 17.

**Table 17 - Scope means**

<table>
<thead>
<tr>
<th>Scope response</th>
<th>Stated WTP Mean (SD)</th>
<th>Final bid WTP Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive response</td>
<td>417.05 (630.236)</td>
<td>504.11 (661.965)</td>
</tr>
<tr>
<td>Negative response</td>
<td>298.61 (491.397)</td>
<td>360.04 (669.267)</td>
</tr>
</tbody>
</table>

An independent sample T test was used to analyse the variance in stated WTP values from participants with different scope responses. The Levene's Test for Equality of Variances indicate that the variance expressed as a standard deviation are not the same ($F = 5.385, p = 0.020$).

Therefore equal variances were not assumed and the results indicate that the difference in stated WTP values by participants with different scope responses was significant ($T = 3.221, DF = $
568.816, \( p = 0.001 \). Using the same test to analyse the variance in final bid WTP values, the results indicate that there is also a significant difference in variance from participants with different scope responses (\( T = 3.115, DF = 1135, p = 0.002 \)).

The mean final bid WTP values for the four starting bids are displayed in Table 18.

### Table 18 – Bidding game start bids, means and standard deviations

<table>
<thead>
<tr>
<th>Start bid</th>
<th>Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td>503.46 (698.697)</td>
</tr>
<tr>
<td>1000</td>
<td>457.09 (571.655)</td>
</tr>
<tr>
<td>1500</td>
<td>464.13 (816.696)</td>
</tr>
<tr>
<td>2000</td>
<td>453.09 (527.825)</td>
</tr>
</tbody>
</table>

Using an one way ANOVA test to analyse the relationship between the starting WTP bid and the final WTP bid, the results failed the test of homogeneity of variances, indicating the variances are significantly different (\( Levene Stat = 2.719, P = 0.043 \)). A Welch test robust to unequal variances was used, which found there was no statistically significant difference between the final bid means and the starting bids (Asymptotically F distributed statistic = 0.355, \( P = 0.786 \)). The lack of a clear correlation between starting bids and final bids is shown in Figure 26.
Multivariate analysis enables results to be interpreted simultaneously considering all the other independent variables in a model. The dependent variable is WTP (both stated and final bid) and the independent variables are age, gender, spectacle ownership, personal income, family income, location, employment status, level of education, VI category and VI status (actual or perceived). The results for the two models are presented in Table 20 below. Age, personal income and family income are continuous variables. All others are categorical. The reference categories for all the categorical variables are listed in the notes below the table. When considering the model diagnostics both models adequately fit the data though the model for WTP final bid seem to offer slightly better fit. The empirical findings of the two models reveal qualitatively similar results.
### Table 20 - Multivariate analysis

<table>
<thead>
<tr>
<th></th>
<th>Stated WTP</th>
<th></th>
<th>WTP Final Bid</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coef.</td>
<td>t</td>
<td>P-val</td>
<td>Coef.</td>
</tr>
<tr>
<td><strong>Age</strong></td>
<td>-3.408*</td>
<td>-2.29</td>
<td>0.022</td>
<td>-3.434*</td>
</tr>
<tr>
<td><strong>Female</strong></td>
<td>-75.502*</td>
<td>-2.23</td>
<td>0.026</td>
<td>-135.60*</td>
</tr>
<tr>
<td><strong>Level of school</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Secondary School</td>
<td>117.775*</td>
<td>2.19</td>
<td>0.028</td>
<td>93.747</td>
</tr>
<tr>
<td>Degree</td>
<td>746.311*</td>
<td>6.67</td>
<td>0.000</td>
<td>822.858*</td>
</tr>
<tr>
<td><strong>Employment status</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Self Employed</td>
<td>-181.67*</td>
<td>-3.4</td>
<td>0.001</td>
<td>-187.37*</td>
</tr>
<tr>
<td>Unemployed</td>
<td>-132.067</td>
<td>-1.96</td>
<td>0.050</td>
<td>-100.464</td>
</tr>
<tr>
<td>Retired</td>
<td>-116.906</td>
<td>-1.02</td>
<td>0.310</td>
<td>-147.964</td>
</tr>
<tr>
<td><strong>Income Personal</strong></td>
<td>16.991</td>
<td>0.64</td>
<td>0.521</td>
<td>-15.429</td>
</tr>
<tr>
<td><strong>Income Household</strong></td>
<td>87.326*</td>
<td>3.95</td>
<td>0.000</td>
<td>156.150*</td>
</tr>
<tr>
<td><strong>Do not have glasses</strong></td>
<td>-29.914</td>
<td>-0.46</td>
<td>0.645</td>
<td>2.647</td>
</tr>
<tr>
<td><strong>Location</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Semi Urban</td>
<td>-30.448</td>
<td>-0.75</td>
<td>0.454</td>
<td>-2.721</td>
</tr>
<tr>
<td>Rural</td>
<td>-99.684*</td>
<td>-2.47</td>
<td>0.014</td>
<td>-91.038*</td>
</tr>
<tr>
<td><strong>VI Category</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mild VI</td>
<td>31.582</td>
<td>0.34</td>
<td>0.737</td>
<td>29.921</td>
</tr>
<tr>
<td>Moderate VI</td>
<td>20.214</td>
<td>0.26</td>
<td>0.792</td>
<td>48.104</td>
</tr>
<tr>
<td>Severe VI</td>
<td>8.094</td>
<td>0.06</td>
<td>0.953</td>
<td>-88.776</td>
</tr>
<tr>
<td>Near VI</td>
<td>17.733</td>
<td>0.3</td>
<td>0.762</td>
<td>13.475</td>
</tr>
<tr>
<td><strong>VI Actual or Perceived</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Actual but not perceived VI</td>
<td>-122.335</td>
<td>-0.95</td>
<td>0.341</td>
<td>-164.366</td>
</tr>
<tr>
<td>Perceived but not actual VI</td>
<td>9.618</td>
<td>0.24</td>
<td>0.813</td>
<td>8.967</td>
</tr>
<tr>
<td><strong>Constant</strong></td>
<td>656.765*</td>
<td>6.44</td>
<td>0.000</td>
<td>693.372*</td>
</tr>
</tbody>
</table>

**Model Diagnostics**

- F(18,1111) = 20.5300
- Prob > F = 0.0000
- R² = 0.2496
- Adjusted R² = 0.2375
- F(18,1111) = 27.2400
- Prob > F = 0.0000
- R² = 0.3062
- Adjusted R² = 0.2950

Note: * significant at 5 per cent level. Reference categories: * No secondary; ¹ Employed; ² Urban; ³ No VI; ⁴ Actual and perceived VI
The multivariate analysis indicates that WTP declines with age and this relationship is statistically significant at the 5 per cent level. It was also found that compared to the males, WTP of females is lower (75.5 for stated WTP and 135.6 for final bid) and this too is significant at the 5 per cent level. Compared to the reference category of those participants with no secondary schooling, the WTP of participants with a degree is considerably higher (by 746 for stated WTP and by 822 for the final bid) and is statistically significant.

The difference between participants with no secondary education and those with a secondary education was found to be significant for stated choice WTP but not for final bid WTP. Compared to those participants who are employed, the self-employed participants have a low WTP. Participants who are unemployed or retired were found to be less willing to pay than those who are employed, but this is not statistically significant.

While household income is found to have a strong positive statistical relationship with both WTP values, personal income has only a weak positive relationship that is not statistically significant. With regards to geography, compared to participants from urban locations, those from rural locations have a low WTP, which is statistically significant at the 5 per cent level. All of the remaining independent variables tested in these two models, including actual and perceived VI, were found to not be significant.

7.4 Discussion

Participants lived equally in urban, semi-urban and rural areas. The gender balance of participants was equal, with slightly more males being included than females. The range of dependent children was quite varied, indicating the variety of family situations in Mozambique. Stated literacy was high, despite 85.4% of participants having never finished secondary school.
Only 15.1% of participants had formal employment. This, combined with the finding that 77.7% of participants earning less than $2 a day, has obvious implications for tax revenue and sustainability of public services, including provision of health care.

From the 665 participants who had actual or perceived VI, only 43% of these knew where to get their eyes tested, suggesting further investment is needed in advertising eye clinics and the services they provide. Half the people who had had spectacles had bought them on the street. When a patient has an eye test by a trained professional, there is the opportunity to identify a range of other eye problems other than URE. When people buy the spectacles they need from the street, they miss out on the opportunity to have a full eye test. The powers of supply and demand will result in spectacles being sold by street vendors if there is not an affordable alternative option available. It is clear that the members of society with more resources available to them either access eye health services in Maputo or in neighbouring South Africa. The public services must aim to address the needs of those members of society that are disadvantaged.

The mean stated WTP value was found to be 388.92 Meticals (SD. 602.092) ($12.84). The mean final bid WTP value was 469.89 Meticals (SD. 666.240) ($15.51). This suggests that employing a negotiation process, has leads to a higher WTP value than the stated WTP methodology. Using a methodology that mirrors every day market transactions, which people are familiar with has been shown to enhance the realism of the analysis (Donaldson et al 2006). Haggling techniques will allow participants to arrive at their true WTP value, allowing them to take the valuation more seriously (Onwujekwe et al 2008).

Age was not found to have an impact on either WTP values. It was clear that the cost these people had paid in the past for spectacles influenced how much they would be willing to pay in the future, with the higher the price previously having been paid being associated with the higher
price they were willing to pay in the future. Although some caution should be applied to the finding, due to only 76 participants having previously had spectacles. Also, participants who already had spectacles were found to have significantly higher values for both stated and final bid WTP. This suggests that, having had their refractive error corrected, that they see value in it and are thus willing to pay higher values for corrective spectacles. They understand the value of the intervention. Increased advocacy about the social, economic and health benefits of eye health may increase the WTP values.

Participants with higher incomes (both individual and family combined) were associated with higher WTP values for both methodologies. This is encouraging, as it is an expected result. As financial resources become more accessible, it would be expected that people would be more willing to invest money in health care. Another expected finding was the significant association between location and WTP. For both methodologies, the WTP value was highest for those living in urban areas and lowest for those living in rural areas. Similar findings were reported in Timor-Leste (Ramke et al 2007). This confirms the regional variations in resource distribution, which policy makers must be aware of if a successful universal eye health service is ever to be achieved. Linked to this finding, those with formal employment were found to present significantly higher WTP values for both methodologies. The link between formal employment and the earning of higher wages renders this finding unsurprising.

For both WTP methodologies, males were found to respond with significantly higher values than females. This may reflect females taking a more conservative approach to household budgeting. Further research is needed into which family member is usually responsible for bringing children to eye health facilities. If it is the women of the family, the value they are willing to pay may be less than if it is the men who are responsible.
A surprising finding was that actual VI level was not found to have an impact on WTP values for either methodology. It was expected that those with severe VI would report higher WTP values, but this was not the case. Also surprisingly, there was also no statistically significant relationship found between the stated WTP means and actual or perceived VI status.

Three quarters of participants responded positively to the scope analysis questions and were found to submit higher WTP values for both methodologies, which is encouraging as for WTP analysis to be theoretically valid, a study must demonstrate sensitivity to changes in scope (Kartman et al 1996). WTP values were shown to increases with the additional increase in benefits (Maxwell et al 2008). As no statistically significant relationship was found between the final bid means and the starting bids, it can be assumed that no starting point bias was experienced for the final bid WTP analysis.

Although the average amount in USD participants would be willing to pay for refractive services was $12.84 for stated choice and $15.51 for the bidding game methodology, the averages are skewed by outlying values. Eight of the stated choice values were equal or above $100, with the highest value being $267. For the final bid WTP, 11 of the final bids were equal or above $100, with the highest final value also being $267.

Table 21 indicates how many of the responses were below, equal to or above the mean. 67% of responses for the stated choice and 66.7% of responses for the final bid were below the mean. Around a third of the people interviewed were willing to pay above the average value for both stated choice and the bidding game.
Table 21 – Responses that are below, equal to, or above the mean

<table>
<thead>
<tr>
<th></th>
<th>Below the mean</th>
<th>Equal the mean</th>
<th>Above the mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stated choice</td>
<td>762 (67%)</td>
<td>0 (0%)</td>
<td>375 (33%)</td>
</tr>
<tr>
<td>Bidding game</td>
<td>760 (66.7%)</td>
<td>3 (0.3%)</td>
<td>374 (33%)</td>
</tr>
</tbody>
</table>

7.5 Conclusion

The average amount in USD participants would be willing to pay for refractive services was $12.84 for stated choice and $15.51 for the bidding game methodology. With nearly 70% of responses for both stated choice and the bidding game being below the mean, attention must be paid by policy makers to those members of society who are least able to pay for eye health. This includes those in rural areas, those without formal employment and those without an adequate education.

7.6 Lessons learned from the WTP and barriers pilot studies.

The following notes were recorded during the pilot study for the WTP and barriers studies. They represent the ongoing learning process involved in data collection.

Firstly, the starting bids are too high for the context of Mozambique. The highest starting bid should be no more than 2,000 Meticals. Money sent from people outside the household cannot be included as individual salary and should be included under household salary. Several data collectors needed to be reminded of this. Some resistance was experienced to answering questions on salaries. This should have been expected. The data collectors should have been clearer that we were recording a range rather than a specific salary. Another problem with
salaries was some data collectors in the pilot study were writing participants’ actual salaries. The salary range is provided to make people more comfortable responding. This point must be clear to data collectors. Where a participant states that they have a very low salary, but a high WTP, data collectors must question their WTP value, asking them to imagine it is a real life situation.

Due to the classification, people with VI for distance do not need a test for VA at near, as VI for distance is prioritised. This can save time. If there is a shortage of people trained to conduct VA tests, this will hold everything up. To avoid a backlog, data collectors not checking VA should go and get participants and bring them back to a central location where VA can be checked by a suitably trained data collector. Also, it would have been useful to have a leaflet describing the current services available from the clinic or the hospital. Several people who required health services asked for directions or a contact number. Where possible, data collectors were encouraged to include the category for VA rather than the code. This would avoid errors during the data analysis.

Each day, the cluster name should be distributed to the data collectors prior to starting work. Some clusters have nicknames or abbreviations, which can make data analysis confusing at a later date. Some dependents appear to live far away, yet still come home from time to time. During the pilot, the data collectors commented that it was not clear if they should be included or not. It was decided that if they considered the property to be their permanent home, then they should be included.

The pilot indicated that each barrier option should have been read by the data collector. On a few occasions, data collectors were observed cutting corners deliberately, or missing out a barrier option by accident. In addition, the cheap talk section must not be skipped or summarised. It is an essential part of the protocol to minimise hypothetical bias. Also, those taking VA must be
checked by supervisors to ensure they are doing it correctly – several errors were observed during the pilot. Supervisors needed to check that all the questions had been answered. On a few occasions, data collectors had got distracted prior to completion of the form. The signature on the consent form is of vital importance and must never be skipped.

It was found that the head of the communities were busy people and cannot stay for the full day of data collection. It was useful to ask them to assign a point of contact in their absence and to assist by introducing me to prominent community members.

Participants should have been asked to state their WTP prior to the bidding game. If the order of questions is reversed, bias may be experienced. In addition, where a specific answer is required, it is easier to interpret the data if a box is provided to fill in. Data collectors must be reminded to write clearly in block letters (not joined up).

Verifying the responses through scope by increasing the durability of the glasses from 4 years to 8 years does not work in this context, as most people do not think that far ahead. Verification must clearly specify the additional benefit. Data collectors should show the bidding game path by drawing on the page which bids were accepted or rejected. This is essential to avoid starting point bias.

Data collectors had to be instructed that errors should be crossed through, rather than just tick another box, leaving two answers on display. In the pilot it was noted that some papers had the unemployed box ticked, but then went on to specify a job. In most cases, the participants were found to be self-employed. This point must be clarified with data collectors. The names of data collectors with exceptionally poor attention to detail were recorded and provided with more supervision.
Chapter 8. Conclusions and recommendations

8.1 Summary

The struggle to secure public funds is competitive both between and within health disciplines. This thesis produces evidence based on findings from economic analysis, which can be used to inform decisions on resource allocation as well as aid advocacy efforts of civil society organisations. The economic burden of blindness and VI on both societies and individuals is recognised as significant (Frick & Foster 2003, Frick et al 2005, Smith & Smith 1996). Although progress has been made, the amount of research that focuses on this topic remains sparse.

The burden of blindness and VI remains great (Naidoo et al 2014). As the leading cause of VI, URE is a major health challenge. Addressing URE can lead to alleviating poverty in the global south. International interest has expanded regarding human resource development as a sustainable solution to addressing URE. The evidence suggests that reducing blindness and VI can be economically beneficial to both societies and individuals. Further investment can be justified as interventions offer good value for money. Addressing URE is specifically economically attractive (Smith et al 2009, Frick et al 2012). Interventions that improve vision or reduce VI are largely highly cost effective and economically desirable in terms of the resulting utility achieved. However more research is needed to comprehensively understand the socioeconomics and economics of poor vision. A better understanding of effective strategies to eliminate avoidable blindness and VI is also needed.

The CBA presented in this thesis has shown that using conservative estimates, the development of optometry as a profession has the potential to achieve a NPV societal benefit of $1.1 billion by
2049 in Mozambique. Optometry is shown to be economically attractive and justifiable. The sensitivity analysis suggest the societal benefit could lie in the range of $649 million to $9.6 billion by 2049, depending on the assumptions employed.

Costs can be justified as they are by far outweighed by the benefits. However, this thesis does not address how the funds will be realised to pay for the public optometry service in Mozambique. The college of optometry at Universidade Lúrio is now established and the graduate optometrists are now being employed by the Ministry of Health. However, further development of the course, service and profession will still present a large cash outflow for the public health sector. Careful planning is needed to ensure the budget is available to employ the optometrists once trained within the public sector. To gain the full potential societal benefit available from the optometrists, they must be offered full employment, be paid regularly and have the tools and facilities needed to practice their profession. If any of these requirements are not met, the optometrists may seek employment in the private sector, consider emigration or change careers. Any of these scenarios would result in the burden of URE in Mozambique remaining high and result in the optometrists training becoming an economic sink. The optometrists being trained must deliver refractive services for their training to be economically and socially justifiable.

The cost analysis indicated that the salaries of the optometrists accounted for over half of the total costs. As this cadre did not exist in Mozambique prior to the start of the course at Universidade Lúrio, careful planning is needed to consider how the salaries of the optometrists are to be paid. As the profession and service develops, there is the potential to create a self-sustaining system through revenues generated by charging for the service. However, the fee should not act as a barrier to those in need of eye health services who do not have resources to
pay for them. The cost of kitting out the optometrists with the necessary tools are also high, as are the non-clinical human resourcing costs of managing a clinic. As optometry will fit into the existing public health system, some of those costs will already be accounted for, but extra financial resources will be needed to ensure the service offered is efficient and effective. If the materials and equipment are not available to allow the clinician’s newly obtained skills to be put into practice, this would represent an ineffective use of resources. In addition, the spectrum of services on offer at a clinic also need to be considered. For example if a clinic offers cataract surgery but does not offer a complementary refraction service, any positive impact on the patient’s vision after surgery may be negated or reduced by lack of suitable refractive correction. For a clinic to be truly efficient and effective, it needs to offer a broad range of eye health services.

CBA, like other economic analysis methodologies, are based on a series of assumptions. This thesis has set out to describe very clearly what assumptions were made and why. Where possible, existing data was incorporated into the analysis. Where no data exists, sensible estimates were made. The sensitivity analysis assesses the validity of the findings by adjusting the assumptions made. Even in the most conservative scenario, the results of the CBA add to the growing body of evidence described in other national and international eye health studies which suggest that investment in eye health, and particularly programmes that address URE, provide good value for money and can be justified economically.

The barriers analysis indicated that cost is the most significant barriers to uptake of refractive services in Mozambique. Cost was stated as a barrier by 35% of all responses and identified by more than half of all participants. Combined with the findings of the RARE study in Nampula Province, which found spectacle coverage rates were 0% for URE and 2.2% for presbyopia,
indicate how inaccessible refractive services are. Mozambique is characterised as having a low proportion of people in formal employment and a high proportion of people living in poverty. As such, it is perhaps no surprise that cost and affordability is the main barrier to access refractive services. Regardless of the resources available to patients, eye health – like all health services, costs money. To overcome the clear disconnect between ability to pay and demand for refractive services, policy makers may need to explore financing models. This may include cross subsidisation, a redistributive national health care system, or a health insurance system. A social entrepreneurial model should be explored and could result in the expansion of services and poverty reduction and should be explored (Naidoo & Jaggernath 2012). For the system to be successful, it must be sustainable and the services must be available to all people, regardless of their financial means (Smith 1995).

After it had been established that cost was the most frequently stated barrier, the natural progression was to establish what people in Mozambique were willing to pay for refractive services. Using two methodologies to verify methodological rigor, the WTP range was established between US$12 and US$15. However, nearly 70% of responses for each methodology would not pay this value.

The burden of presbyopia in Mozambique is known to be large. The majority of people suffering with presbyopia could have their vision improved dramatically with a pair of ready-reader spectacles, which cost no more than a few dollars. If these are prescribed by an optometrist or another trained eye health worker, the patient’s eyes can be checked for other diseases or complications.

Affordability is not always a question of cost. Resources need to be employed efficiently. Both clinical and non-clinical services should provide the best possible quality. Improving quality
sometimes involves initial investment, but can save money in the long term. Many improvements can come at low or no cost and involve the eye health team changing the way they work to make the service more efficient. Offering poor quality services is a waste of resources. It may also damage future or repeat uptake of the services on offer, and may fail to deliver on the opportunity to eliminate cases of avoidable blindness (Lindfield & Foster 2008).

In many countries, the private health sector makes use of many advanced business techniques to operate in an efficient way. For example ‘Just In Time’ delivery systems, if well implemented, can result in significant savings by limiting resources tied up in inventory. To be successful, the public and para-public sector must also adopt these techniques and systems (Smith & Smith 1996 A). Suitable procurement system will be needed to ensure good value for money spectacles are available. Strong leadership and management are essential to the success of any eye health system (Rahmathullah et al 2007). The optics industry alone in many countries is highly developed, probably generating revenues of over $100 billion (Holden & Resnikoff 2002). The private sector exploits logistics, supply and economic management systems that make business efficient, and which could deliver more efficient elimination of avoidable blindness if incorporated into the public sector.

To achieve this goal, the cost of all eye health interventions should be kept as low as possible through efficient business practices (Lindfield & Foster 2008). As exemplified in the private sector, careful planning is needed for interventions to be a success. These plans need to include strategies to train human resources and procure appropriate and affordable infrastructure and technology (Taylor et al 2007). Plans and strategies for the elimination of avoidable blindness need to be integrated into the health system if they are to be effective and make the best use of
existing resources, and would need to address previously defined accessibility issues to maximise service uptake (Faal & Gilbert 2007).

8.2 Contribution of the research

This thesis contributes to several fields including public health, eye health, human resourcing for health, and health economics. Specifically, it introduces novel thinking and applies appropriate and rigorous techniques to these fields in the context of Mozambique. The findings can be applied to sub-Saharan Africa and the wider global south.

In the introductory chapters, the body of evidence is presented, and the existing findings are analysed. An in depth understanding of several topics is presented. The history of Mozambique, economic analyses methodology, WTP analysis, eye health issues, education systems, the political landscape and development in general are discussed. This provides a solid foundation for the analytical chapters. The existing body of evidence was used to underpin analytical decision making and justify methodological choices.

It is accepted that URE is the leading cause of VI and that it has an impact on productivity. The objective of this research project was to quantify this impact, thus testing how economically justifiable it is to develop the profession of optometry in a developing country to address the burden of URE. It also aimed to establish the factors that may prevent the newly trained optometrists from reducing the vision impairment burden to their full potential. The third objective was to evaluate how sight is valued in Mozambique and to establish what people would be willing to sacrifice in exchange for improved vision through refractive services.

Research into the burden of blindness and VI in Mozambique is extremely limited. The Ministry of Health, international NGOs and civil society are aware that blindness and VI is an ongoing
problem in Mozambique. A handful of prevalence studies focused on blindness and VI in Mozambique exist (Kimani 2011, Bedri 2014, Loughman et al. 2014), but apart from these there is a paucity of research into the burden and impact of blindness and VI in Mozambique. The CBA study presented in this thesis is the first known example of economic analysis being applied to a specific eye condition in Mozambique. It follows a standard methodology, yet it uniquely considers how unaddressed refractive error impacts on productivity in Mozambique. The results indicate that even with the inclusion of conservative estimates and reduced DWs, investing in optometry as a profession makes economic sense. The results demonstrate that even in a country with relatively low productivity in comparison with the rest of the world, if refractive error goes unaddressed, society will remain restricted from reaching its productive potential.

There are now several Schools of Optometry on the African Continent (Oduntan et al. 2014). An important contribution of this thesis is the breakdown of costs of the optometry profession from enrolment to university to retirement from practice. What is very clear from the results of this investigation is that by far the most significant cost is employing the optometrists once they are trained. A long term economic commitment to the newly trained optometrists must be made if the goal of eliminating avoidable blindness and VI is to be achieved. It is not enough to establish a course. If funds are not available to pay the optometrists’ wages, training them in the first place becomes a wasteful process, and arguably more importantly, VI due to URE will persist as a burden.

With regards to how the general access the services, the barriers analysis presented in this thesis reaffirms what is known from regional studies that cost is the most significant barrier in the context of Mozambique. A system must be implemented where a patient’s access to funds will
determine their access to improved vision. This finding is particularly pertinent after the launch of the GAP for the Prevention of Avoidable Blindness and Visual Impairment 2014-2019 (WHO 2013). The plan clearly sets the goal of working towards universal eye health as a means to reducing avoidable VI as a global public health problem and to secure access to rehabilitation services for those suffering VI. To achieve comprehensive eye health services must be improved and integrated into health systems and not restricted to those with the means to pay.

The results of the WTP chapter offer for the first time primary data on how people value refractive services in Mozambique. As well as offering WTP values derived from two different methodologies, the study assesses the participants’ likelihood of being able to afford the value, based on their earnings. Although Mozambique is developing fast with strong economic growth over the last 10 years, compared to neighbouring countries, years of conflict and environmental disasters left the country with a significant proportion of the population living in poverty and relying on informal employment. The system established to combat URE must take into account that the majority of people do not have the means to pay for the service they require.

8.3 Key recommendations

This thesis investigated potential key determinants of the success, or otherwise, of endeavours to address avoidable VI caused by addressing URE in Mozambique by providing optometric services. The following are key recommendations proposed as a result of the outcomes of this research.

Firstly, through analysing the optometry training programme developed in Mozambique, it is clear that investing in human resources for eye health is economically and socially justifiable.
However, it is also clear that the cost of training optometrists are dwarfed by the cost of employing them and providing them with the equipment to address blindness and VI. Further research is needed to explore funding pathways, models of service delivery and revenue recuperation.

Investigation is needed to establish other health professions that maybe currently missing or underdeveloped in Mozambique, which need investment. The lack of human resources for eye health are a concern. To maximise efficiency and to ensure good governance, efforts should be made to integrate refractive services and optometry as a cadre into the existing health system. Further research is also needed to assess the financial input needed for Mozambique to achieve the VISION 2020 goal of eliminating avoidable blindness and VI.

Refractive services, like all health services, must be sustainable. Cost of refractive services is shown to be a key barrier to access. As such, careful planning is needed to ensure that those who need to access eye health can do so, regardless of their access to resources to pay for it. Further research is needed into which financing system would work in Mozambique.

With regards to the planning of refractive services, particular attention must be paid to the needs and requirements of the most vulnerable members of society. The needs of the poor, those in rural areas, women and children, and those with multiple disabilities must be considered. Average WTP values for an eye test and spectacles is between US$12 and US$15. The needs of the majority population who cannot afford this must be taken into account. Cost must be removed as a barrier to access. A procurement system must be established that is suitable for the context of Mozambique and ensures good value for money. Decentralisation of services should be explored so that refractive services are more easily accessible.
References

Abdullah K, Al-Sharqi O, Abdullah M. Barriers to the uptake of eye care services in developing countries: A systematic review of interventions. Health Education Journal, 2012; 0 (0)


http://aulp.org/


Bala M, Mauskopf J, Wood L. Willingness to pay as a measure of health benefits. Pharmacoeconomics, 1999; 15


Bedri A. RAAB study in Mozambique helps better planning of eye health services. Vision and Development, 2014; 1


Blanchet K, James P. Can international health programmes be sustained after the end of international funding: the case of eye care interventions in Ghana. BMC Health Services Research, 2014; 14 (77)


Cabinda M. The need for a needs analysis at UEM: Aspects of and attitudes towards change. Linguistics and education, 2013; 24


Courtright P. Gender and Blindness. Part of Gender and Health, 2002. World Health Organization, Geneva, Switzerland

Courtright P, Bassett K. Gender and Blindness: Eye Disease and the Use of Eye Care Services. Community Eye Health, 2003; 16 (45)


Dandona R, Dandona L. (b) Socioeconomic status and blindness. British Journal of Ophthalmology, 2001; 85


Davis R. Recreation planning as an economic problem. Natural Resources Journal, 1963, 3


Ebeigbe J. Traditional eye medicine practice in Benin-City, Nigeria. The South African Optometrist, 2013; 72 (4)


Evans J, Fletcher A, Wormald R. Depression and Anxiety in Visually Impaired Older People. Ophthalmology, 2007; 114 (2)

The Fred Hollows Foundation. The Value of Sight. The Fred Hollows Foundation, Australia, 2013.

Faal H. Millennium development goals and eye health. Indian Journal of Ophthalmology, 2012; 60 (5)


Foster A, Resnikoff S. The impact of Vision 2020 on global blindness. Eye, 2005; 19


Free World Maps (FWM) accessed 11.082014

http://www.freeworldmaps.net/africa/mozambique/location.gif
Frew E, Wolstenholme J, Whynes D. Comparing willingness-to-pay: bidding game format versus open-ended and payment scale formats. Health Policy, 2004; 68

Frick K, Baruwa E. The paradox of economic tools promoting equitable access to self sustainable services for the poorest - increased inequality. Tropical Medicine and International Health, 2007; 12 (7)

Frick K, Foster A. The magnitude and cost of global blindness: an increasing problem that can be alleviated. American Journal of Ophthalmology, 2003; 135 (4)


George A, Iyer A. Unfree markets: Socially embedded informal health providers in northern Karnataka, India. Social Science & Medicine, 2013; 96


Gurung R. Cataract surgical outcome and gender-specific barriers to cataract services in Tilganga Eye Centre and its outreach microsurgical eye clinics in Nepal. Community Eye Health Journal, 2007; (20) 61 MSc summary


http://www.iapb.org/home


Kartman B, Stalhammar N, Johannesson M. Valuation of health changes with the contingent valuation method: a test of Scope and question order effects. Health Economics, 1996; 5


Keller K. Investment in primary, secondary, and higher education and the effects on economic growth. Contemporary Economic Policy, 2006; 24 (1)


Kuper H, Polack S, Eusebio C, Mathenge W, Wadud Z, Foster A. A case control study to assess the relationship between poverty and visual impairment from cataract in Kenya, the Philippines and Bangladesh. PLoS Medicine, 2008; 5 (12)


Lang H, Chang K, Ying Y. Quality of life, treatments, and patients' willingness to pay for a complete remission of cervical cancer in Taiwan. Health Economics, 2012; 21


Lester B. Comparing the cost-effectiveness of school eye screening versus a primary eye care model to provide refractive error services for children in India. Community Eye Health Journal, 2007; 20 (61)


Loomes G, McKenzie L. The use of QALYs in health care decision making. Social Science & Medicine, 1989; 28 (4)


McIntosh E, Donaldson C, Ryan M: Recent advances in the methods of Cost-Benefit Analysis in healthcare: matching the art to the science. Pharmacoeconomics, 1999; 15 (4)

McMahon W. Education and growth in East Asia. Economics of Education Review, 1998; 17 (2)
Melese M, Alemayehu W, Friedlander E, Courtright P. Indirect costs associated with accessing eye care services as a barrier to service use in Ethiopia. Tropical Medicine and International Health, 2004; 9 (3)


National Health Service (NHS). Accessed 17.08.14 –
http://www.nhs.uk/

Naidoo K, Poverty and blindness in Africa. Clinical and Experimental Optometry, 2007; 90 (6)


Neumann P. What Next for QALYs? JAMA, 2011; 305 (17)


O'Brien B, Gafni A. When do the "dollars" make sense? Toward a conceptual framework for contingent valuation studies in health care. Medical Decision Making, 1996 16 (3)


Onwujekwe O, Fox-Rushby J, Hanson K. Construct Validity of the Bidding Game, Binary with Follow-up, and a Novel Structured Haggling Question Format in Determining Willingness to Pay for Insecticide-Treated Mosquito Nets. Medical Decision Making, 2008; 28 (1)


Patient Protection and Affordable Care Act (PP & ACA). Public Law, 2010; 111-148, USA.


Preslan M, Novak A. Baltimore Vision Screening Project – Phase 2. Ophthalmology, 1998; 105 (1)


Quigley H. Glaucoma. The Lancet, 2011; 377

Quigley H, Broman A. The number of persons with glaucoma worldwide in 2010 and 2020. British Journal of Ophthalmology, 2006; 90


Salomon J, Vos T, Murray C. Disability weights for vision disorders in Global Burden of Disease study — Authors' reply. The Lancet, 2013; 381

Seva. Gender and Blindness: Initiatives to address inequity. Seva, 2012; Canada.


Smith A. Ophthalmic services research: towards increasing the role of economic and operations research methods in the delivery of eye care services. British Journal of Ophthalmology, 1995; 79


Sommer A. Towards affordable, sustainable eye care. International Ophthalmology, 1995; 18

Saulo E, Forsberg B, Premji Z, Montgomery S, Bjorkman A. Willingness and ability to pay for artemisinin-based combination therapy in rural Tanzania. Malaria Journal, 2008; 7 (227)


http://arrow.dit.ie/otpomart/28/

du Toit R, Ramke J, Palagyi A, Brian G. Spectacles in Fiji: need, acquisition, use and willingness to pay. Clinical and Experimental Optometry, 2008; 91 (6)

UCCS Effect Size Calculator. Accessed 24.12.14 -
http://www.uccs.edu/~lbecker/


http://www.unicef.org/mozambique/education_2935.html

UniLurio – Universidade Lúrio - Programa Um Estudante, Uma Família. Accessed 12.08.14
http://www.unilurio.ac.mz/unilurio/index.php/programas


Wang H, Zhang L, Hsiao W. Ill health and its potential influence on household consumptions in rural China. Health Policy, 2006; 78


Wilson D, Cronje S, Frick K, Holden B. Real cost of Recycled Spectacles, Optometry and Vision Science, 2012; 89 (3)


211
World Health Organization, 2014, Geneva, Switzerland


World Health Organisation Metrics (WHO Metrics). Disability-Adjusted Life Year (DALY). Accessed 20.08.14 -
http://www.who.int/healthinfo/global_burden_disease/metrics_daly/en/

http://www.who.int/blindness/data_maps/en/
WHO Regional Office for Europe (WHO ROE). Mainstreaming gender equity in health: the need to move forward (Madrid Statement), WHO, 2002; WHO Regional Office for Europe Copenhagen, Denmark


http://www.who.int/eportuguese/en/


http://www.who.int/mediacentre/factsheets/fs290/en/

World We Want (WWW). Health in the Post-2015 Development Agenda. Accessed 14.08.14 -

http://www.worldwewant2015.org/health