UNIVERSITY OF CAPE TOWN
IYUNIVESITHI YASEKAPA • UNIVERSITEIT VAN KAAPSTAD

KEY INFORMANTS FOR PEDIATRIC EYE DISEASE CASE FINDING IN MADAGASCAR

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(CHMAND003, 2016)

Dissertation Submitted in Partial Fulfillment for the requirements for the degree Masters in Public Health, Community Eye Health; School of Public Health, Faculty of Health Sciences and Family Medicine, University of Cape Town

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HREC REF 736/2016

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August 2018

DECLARATION

I, **Dr Chimeziri Anderson**, hereby declare that the work on which this dissertation/thesis is based is my original work (except where acknowledgements indicate otherwise) and that neither the whole work nor any part of it has been, is being, or is to be submitted for another degree in this or any other university.

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Key Informants for Paediatric Eye Disease Case Finding In Madagascar

Abstract

This research undertaken for MPH dissertation, analysed and estimated the prevalence of paediatric eye diseases in Madagascar using the key informant programme and quantified the productivity of the key informants.

Part A is the research protocol, which outlines the background and the process of this research. This study is a secondary data analysis of cross sectional data collected in Madagascar.

The approach was to estimate both the prevalence of eye defects in children and to assess the productivity of the key informants responsible for case finding in the communities.

Part B is Literature review of published articles, online reports, and summaries on childhood blindness studies and surveys.

Part C presents the research project in a format suitable for journal submission.

The background of the research is summarised and the results are presented and discussed.

PART A: PROTOCOL

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1.0 Purpose of study

The purpose of this study is to estimate the prevalence of childhood eye diseases in Madagascar

1.1 AIM

The aim is to use the findings from the key informant program in four regional sites in Madagascar to quantify eye defects among children and the productivity of the Key informants

1.2 OBJECTIVES

The objectives of this study are as follows:

I. To quantify the cases of children who have eye conditions (identified by KI in the communities) among all children resident in the catchment area.

II. To quantify the productivity of KI in identifying children with eye conditions.

III. To quantify the specific childhood eye diseases and demographic characteristics of these children

1.3 Abstract

As at 2014, 19 million children aged < 16 years were visually impaired, 1.4 million of these children were blind and needed visual rehabilitation interventions. Surveys, mostly utilizing key informants (KI), have suggested that the prevalence of blindness in children in Sub Saharan Africa ranges between 2 -8 per 10,000 children. Childhood eye disease is rare and conditions are difficult to detect; thus, surveys to estimate the prevalence of blindness requires rigorous, costly and difficult methods to obtain reasonable estimates among children. Key informant programs, which engage the community in case finding, have been shown to be a reasonable alternative to large scale surveys and were used in Madagascar in 2014 by four regional eye care programmes. I propose to analyse the data generated from the programmes to quantify the prevalence of eye conditions among children and how the KIs performed.

Method: The analysis will use data collected in a cross sectional approach. Statistical analysis will be conducted using Stata (15.0) statistical software. Data from all of the KI registers will be pooled and overall magnitude estimates calculated. KI productivity and sub-group analyses will include assessment of demographic characteristics of the children and the KI by age and sex. Ethical approval will be provided by the UCT Health Research and Ethics Committee and the Madagascar Ministry of Health.

Discussion: The results from this study will help child eye health programmes to determine how best to use KI to better serve children with vision loss, and guide in the provision of eye services for children care.

Keywords; visual impairment, blindness, key informants, childhood, eye care, Madagascar

1.4 Background

Blindness (BL) is defined as a presenting visual acuity (VA) of less than 3/60 in the better eye or visual field of less than 10^0 radius around central fixation. Severe visual impairment (SVI) is defined as a presenting VA of less than 6/60 but 3/60 or better (World Health Organization, 2014). In infants who cannot respond to examiner instructions, VA is measured by the ability of "fix and follow" and other method. It was estimated in 2014 that there were 19 million children age 15 years or younger who were either visually impaired, with severe visual impairment or blind. Of this number, an estimated 1.4 million children were blind and need visual rehabilitation interventions to achieve functional psychological and personal development (Kong et al., 2012). A review (Gilbert and Foster, 2001) reported that over 70% of children with SVI/BL live in developing countries, have high death rate, and prevalence of blindness ranges from 0.3 per 1000 in high income countries to 1.5 per 1000 children in low income countries. This review is now 16 years old and recent African population based studies, mostly utilizing KIs, have suggested that the prevalence of blindness in children ranges between 0.2-0.8 per 1000 children (Courtright, 2012, Shirima et al., 2009, Duke et al., 2013b, Kalua, 2007). Identification of these children early in life for preventive, medical, or optical interventions has been the major challenge of the control of childhood vision loss.(Bronsard et al., 2008)

There are relatively few population based surveys of childhood blindness; this is due to technical, cultural, psychosocial and economic factors involved in undertaking a childhood blindness survey (Courtright, 2008). The skill and expertise required to diagnose vision loss and causes in children are major challenges to population surveys in developing countries (du Toit et al., 2017).

Childhood eye diseases are rare and to conduct a population based study requires large sample sizes. (Gogate and Muhit, 2009, Gilbert and Foster, 2001). Measuring VA accurately in children in a field setting can be very difficult, particularly in infants and in those with additional disabilities.

Various methods have been used to try to determine the causes of blindness among children; these studies include survey of children in schools for the blind, use of hospital based registers, registers for the blind, or birth cohort registers. School for the blind studies documented causes rather than prevalence. A review ((Gogate and Muhit, 2009), of findings from recent schools for the blind surveys in sub-Saharan Africa (SSA) documented that causes of childhood blindness varied. The two major affected sites were corneal and lens. In the documented studies in Nigeria, disease of the lens was 26.7% (Onakpoya et al., 2011) and 13% (Okoye et al., 2009) , in Ghana, it was 23% (Ntim-Amponsah and Amoaku, 2008), in East Africa (Malawi, Kenya, Tanzania and Uganda) it was 13% (Njuguna et al., 2009) and in Cameroon it was 19.6% (Noche and Bella, 2010). Corneal disease was reported in four studies; Ghana (59.7%), Cameroon (32%), Nigeria 2009 (20%) and East Africa (19 %); most of these cases were in older children. The methods used have limitations, most suffer from selection bias; they only include school age children, children with corneal conditions (being obvious to detect) are more likely to be enrolled, and girls are less likely to be in these schools. Hospital records only account for children who were brought for assessment and there is no adequate record on follow up. Blindness registers are more common in developed countries that have an efficient birth registry in which children with blindness are listed (Solebo et al., 2017).

There has been a growing proof of effective strategies to find and refer children with eye problems. Most of these strategies uses the community members (du Toit et al., 2017) to seek , find and refer SVI/BL children, particularly with conditions that could be managed by surgery, optical correction, or rehabilitation. All the reported studies found that it is essential to engage with the community in order to identify children needing assessment.(Kalua et al., 2009, Shirima et al., 2009, Demissie and Solomon, 2011, Muhammad et al., 2010) . Qualitative research has also demonstrated the challenges to identifying children with SVI/BL; these include parents feeling that there is no alternative to a life spent in blindness, either because they believe that there is no cure or that the condition is a chastisement from 'God' for some individual or family transgression (Bronsard et al., 2008). A study in Tanzania (Kishiki et al., 2012) found that workers at frontline health facilities either tried to treat the condition themselves or told parents to "wait until the child is older" before seeking eye care services. The cited studies also highlighted experiences in many rural health settings in Africa where frontline health workers may end up serving as "gate keepers" when people come to the health facility for care and referral. There also may be limited community-based activities by health workers.

Recognizing these challenges and many others not listed, a novel approach by the use of KI (Muhit et al., 2007) was developed and has been used in the last two decades in several SSA countries to identify children with SVI/BL. Much of the published work on KI had the objective of assessing the prevalence of children with SVI/BL while others sought to test different strategies to screen and refer children for appropriate care. KI refers to community members who, after a very brief training are expected to network widely to identify children in their communities with SVI/BL. (Gogate and Muhit, 2009, World Health Organization, 2014) In most cases, KI's work in campaign mode linking to a specific childhood focused outreach and bring those identified to the designated outreach for examination by specialized health care personnel. All KI keep a register of identified children after which these registers are collected, making it possible to compile and document the findings.

1.5 Setting: Madagascar (Fig 1. 1) is an island country in the Indian Ocean east of Mozambique. It has a population of about 25 million of whom 11 million (42%) are children less than 16 years of age. About 65% of the population dwells in rural areas, living below the poverty line of $1.25 per day (Gaffikin et al., 2007). The country is divided into 22 regions. It is listed as number 151 out of 187 countries in the UN Human Development Index. Many health services rely on global and NGO donation and there are large inequalities between regions (Razafison 2008). In a recent study in Atsinanana Region, 64% of blindness was attributed to cataract (Randrianivo et al 2014) of which the vast majority should be treatable. Eye care facilities and treatment in Madagascar is provided on a fee for service basis, however, there are many initiatives from NGOs to help pay for some or all of the cost of treatment for those least able to pay. Eye care manpower coverage is low with one to two eye surgeons per million populations and fewer than two of any other type of eye care professional. (Randrianotahina and Nkumbe, 2014) (IAPB 2011). Up until recently, there was no child eye health tertiary facility (CEHTF) in the country as recommended by the World Health Organization. In 2014, a CEHTF was established in the capital city, Antananarivo. Overall there are 60 ophthalmologists in both private and public practice (Norris et al., 2009). Historically, there have been no ophthalmic nurses, ophthalmic clinical officers or optometrists in Madagascar and none were working in the country as of 2011. Using calculations from Tanzania, it was suggested that more than 2500 children were living with blindness from non-traumatic cataract in Madagascar

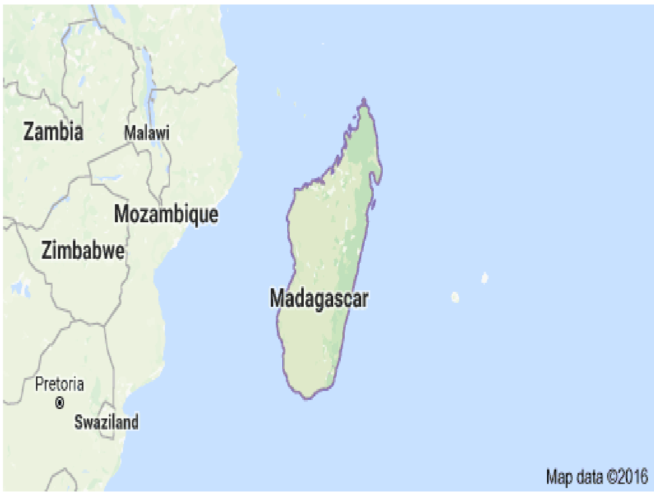

Figure 1.1 Map of Madagascar and neighbouring countries

(Nkumbe and Randrianotahina, 2011). The study was one of very few articles on childhood blindness in Madagascar.

1.6 Statement of the problem; The KI method has been used in several SSA countries to identify children with SVI/BL. KI work was done as a survey or as a programme activity. Based on experiences in Tanzania and Malawi, an Africa-focused KI training guideline was developed (Shija et al., 2012). The productivity of KI was documented in Malawi and Nigeria (Kalua et al., 2009, Duke et al., 2013a, Duke et al., 2014) and studies in Malawi and Tanzania have compared the use of community based KI with formal health workers. There have been no studies using KI in Madagascar to determine how effective the KI are at identifying children. The aim of the present study is to use the data from a 4 region KI project in Madagascar to assess the prevalence of childhood eye diseases in the project area and to assess the relative productivity of KI.

1.7 Research questions; we plan to address the following research questions:

1 What is the prevalence of childhood eye disease among children in the Madagascar programme sites?

2 What are the major childhood eye diseases among children in the Madagascar programme sites?

3 What are the demographic characteristics of children who have childhood eye disease in the programme populations?

4 What is the productivity of the KIs in identifying children with eye conditions?

1.8 Significance of the study: Blindness in childhood contributes to a lifetime of low self-esteem, low learning capacity, productivity and dependency. Although the number of blind children may be few when measured in absolute figures, when considered relative to the number of years lost due to disability (DALY's) it befits a public health importance. In addition, blind children have a higher death rate so the ''prevalence likely underestimates the burden' (Gilbert and Muhit, 2012). Blindness and low vision also affect families and communities for generations as the loss of income and productivity drives families deeper into poverty (Gilbert, 2001).

Early intervention is critical to ensure good vision for life, but in Madagascar, fewer than 20% of children receive the treatment they require. (Randrianotahina and Nkumbe, 2014). Most parents in Madagascar have no understanding of eye disease; they don't know about childhood blindness and they don't know that many eye conditions are treatable. Even if the parents did recognize eye disease they often do not have access to a health practitioner that could provide information or referral.

The analysis in this study will add to the currently limited body of knowledge about KI and provide evidence for estimation of prevalence of childhood eye disease among children in Madagascar and the productivity of the KI

1.9 Acronyms

CHILDHOOD	Children between ages of 0-15 years
CI	Confidence Interval
DALY'S	Disability Adjusted Life Years
IAPB	International Agency for Prevention of Blindness
KI	Key Informant
KIM	Key Informant Methods
Malagasy	A person or citizen from Madagascar
NGO	Non-Governmental Organization
SSA	Sub-Sahara Africa
SVI/BL	Severe Visual Impairment/ Blindness
VA	Visual acuity
WHO	World Health Organization

2.0 Materials and Methods

In 2014, SEVA Canada and the Kilimanjaro Centre for Community Ophthalmology (KCCO) with local Malagasy partners supported direct eye care service delivery at four hospitals in four regions: Ambohibao hospital in Analmalanga Region (near the capital city Antananarivo), Tamatave Hospital in Atsinanana Region, Antsirabe Hospital in Vakinankaratra Region and Sambava Hospital in SAVA Region (fig 1.2, Table 1). The project also targeted support for community outreach activities to rural populations, so that people most in need of eye care have access to treatment. The paediatric program also included training a network of KI to find and refer children with eye conditions and capacity building at each of the hospitals to manage as many of these children as possible. Fig 1, 2, shows the regions and sites of the program. See appendix 1 for detailed Map.

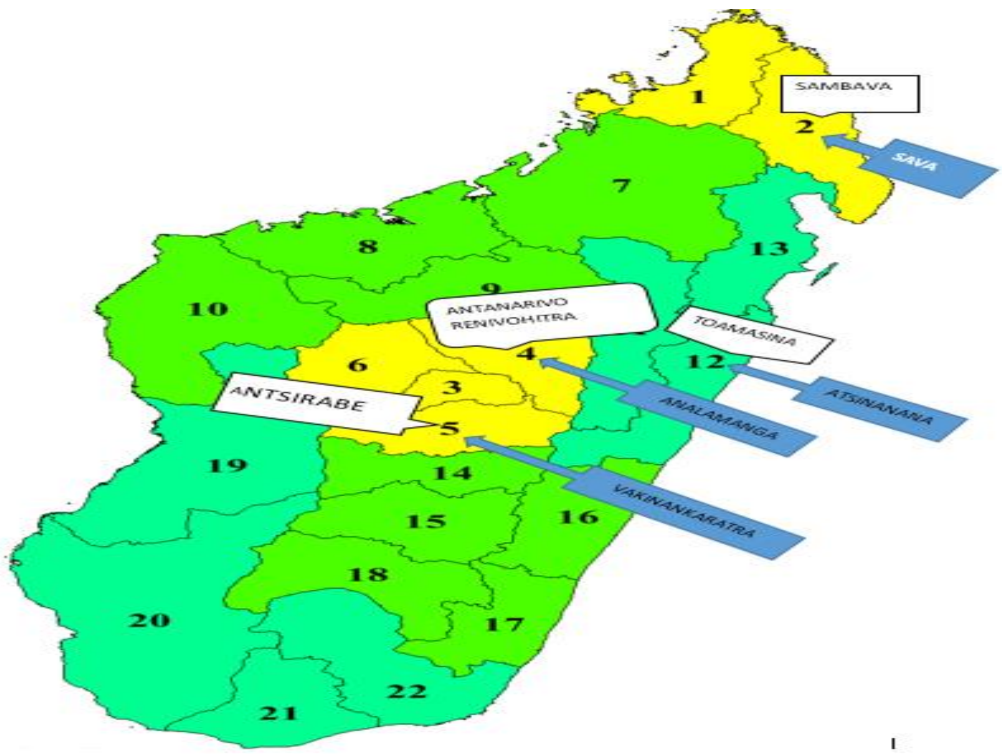

Figure 1.2 Map of Madagascar showing study site

Table 1. Description of Regions in the MAP, population and capital

Number in	Region	Population	Capital
1	Diana	700,021	Antsiranana
2	SAVA	980,807	Sambava
3	Itasy	732,834	Miarinarivo
4	Analamanga	3,348,794	Antananarivo
5	Vakinankaratra	1, 803, 307	Antsirabe
6	Bongolava	457,368	Tsiroanomandidy
7	Sofia	1, 247, 037	Antsohihy
8	Boeny	799,675	Mahajanga
9	Bestsiboka	293 ,522	Maevatanana
10	Malaky	289,594	Maintirano
11	Alaotra-Mangoro	1,027,110	Ambatondrazaka
12	Atsinanana	1,270,680	Toamasina/Tamatave
13	Analanjirofo	1,035,132	Fenoarivo-Atsinanana
14	Amoron'i Mani	715,027	Ambositra
15	Matsiatrany Ambony	1,119,183	Fianarantsoa
16	Vatovavy-Fitovinany	1,416,459	Manakara
17	Atsimo-Atsinanana	898,702	Farafangana
18	Ihorombe	312,307	Ihosy
19	Monabe	592,113	Morondava
20	Atsimo-Andrefana	1,316,756	Toliara
21	Androy	733,933	Ambovombe-Androy
22	Anosy	671, 805	Tolanaro

The KI program was judged to be most efficient method in this setting and in the specific selected centres that undertook training of KI, organization of outreach, and referral of children for necessary services. All KI underwent standardized training and were deployed back to their communes (Table 2) to identify children with SVI/BL. Cases identified by KI were assembled at an outreach and examined by the eye care team.

2.1 Sample size /site. A total of 9 communes in four regions with a total population of 377,613 were included in the programme. In total 221 KI (52 men and 169 women) were recruited. In the four programme areas the KI to population ratio was 1:1700. (Table 2)

Table 2. Project site and populations

Region	Communes	Population (Number)	KI (Number)	
			Male	**Female**
Analmalanga	Ambohibao	65,137	3	33
	Felarivo-Ampitatafika	56,706	1	20
Sava	Ampanafina	20100	5	9
	Antalaha	68000	10	19
Atsinanana	Betainomby	41,171	3	13
	Vatomandry	38,566	0	22
	Anivorano	12,783	12	19
Vakinankaratra	Ambano	41,636	4	20
	Ankazimiriotra	31,514	14	14
Total Population	**Nine Communes**	**377,613**	**52**	**169**

2.2 Study design: This is a secondary data analysis of a population based patient identification program using KI. KIs were not trained to examine children; rather, they were instructed to rely on community and family reports to identify and access children with vision problems. A child was defined according to the World Health Organization (WHO) definition of age <16 years. KIs were encouraged to use various methods to engage the community, including house-to-house visits; school, church or market visits and town square meetings. They were asked to bring identified children to pre-determined local screening sites or to the regional hospital for examination. After training, they had 2 weeks to carry out their work. A week before and two days before the outreach date, they were reminded by text messages. Examinations were carried out at the predetermined sites by an ophthalmologist with training in paediatric eye care. Children were examined by the ophthalmologist using direct or indirect ophthalmoscopy with dilated pupils (2% cylco- pentolate, 2.5% phenylephrine). Findings were recorded as the specific eye condition (or normal eye) if no eye condition was noted.

2.3 Source of data: Data collection will be extracted from KI registers and clinical examinations recorded on an excel spread sheet. The variable extracted from their data were age of the child, gender, eye conditions diagnosed, attendance to outreach: 1= if the child attended the outreach and seen by the ophthalmic team, 2= if not attended the outreach; walk in (1= if the child came directly to the hospital by himself or brought by his/her parents, (not brought by a K.I), 2= the child was brought to the outreach camp by the KI). Eye conditions identified by ophthalmic team were coded as 0= Not seen, 1 = Normal eye, 2=Conjunctival diseases, 3= Refractive error, 4= Cataract, 5= Suspected retinoblastoma, 6=Glaucoma, 7=others, 8= Strabismus. Information collected on the KI included: age of KI, sex of KI, number of children referred, and proportion of children who presented at outreach.

2.4 Data collection procedure: Clinical examination which included findings from the visiting ophthalmologist on the diagnosis of eye disease in the children will be imported from Excel into Stata 14. A register of all of the KI who were trained and deployed will be collated.

2.5 Inclusion Criteria: Only data from KI's population-based case finding on children <16 years of age in the four programme areas will be included in the analysis.

2.6 Data storage and analysis: Data will be kept in my personal computer which has a password and accessed only by the author. Personal identifiers will be shielded with serial numbers. Statistical analysis will be conducted using Stata (15.0 Stata Corp., College Station, TX, USA) statistical software. Data from all of the KI registers will be pooled and overall magnitude and effect estimate will be calculated. Sub-group analyses included assessment of demographic characteristics of the children and the KI by age and sex. Mean values and Students' tests will be calculated. Odds ratios and 95% Confidence intervals will be used to assess differences among dichotomous or categorical variables. All statistical results will include 95% CI and α value of 0.05

2.7 Description of risks and benefits

Minimum risks were anticipated from this study as only secondary data will be used for the analysis. This analysis was carried out in collaboration with the Ministry of Health in Madagascar who provided permission to use the data.

It is hoped that the Malagasy Ministry of Health's eye care programme can use the findings to better plan for eye health services for children. The publication of the findings from this study will help to disseminate information on paediatric eye care in Madagascar which may attract attention by program agencies to extend assistance for paediatric eye care in the country.

2.8 ***Potential risks and discomforts:*** Minimum risks and discomfort is anticipated as secondary data is used for this study.

2.9 ***Potential benefits:*** The results from this study will inform planners and implementers of childhood vision loss programmes to determine how best to use KI to serve children with vision loss as well as how to better use KI for case finding.

3.0 ***Informed consent process:*** At the time of this programme, informed consent was provided by all parents on behalf of their children. The programme was approved by the Madagascar Ministry of Health. (See appendix)

3.1 ***Capacity to consent***: No additional informed consent was needed for the secondary analysis.

3.2 ***Ethics***: Ethical review approval was provided by the University of Cape Town Research and Ethics Committee. (See Appendix)

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Protocol

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3.2 List of tables and figures

Appendixes

1 Detailed Map of Madagascar with red highlights on study sites

II Ethics approval from UCT

UNIVERSITY OF CAPE TOWN
Faculty of Health Sciences
Human Research Ethics Committee

Room E53-46 Old Main Building
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Website: www.health.uct.ac.za/fhs/research/humanethics/forms

20 March 2017

HREC REF: 736/2016

Prof Paul Courtright
c/o Ophthalmology Division
H53, OMB

Dear Prof Courtright

PROJECT TITLE: KEY INFORMANTS FOR PEDIATRIC EYE DISEASE CASE FINDING IN MADAGASCAR (MPH-candidate-Dr C Anderson)

Thank you for submitting your study to the Faculty of Health Sciences Human Research Ethics Committee.

It is a pleasure to inform you that the HREC has **formally approved** the above-mentioned study.

Approval is granted for one year until the 30 March 2018.

Please submit a progress form, using the standardised Annual Report Form if the study continues beyond the approval period. Please submit a Standard Closure form if the study is completed **within** the approval period.
(Forms can be found on our website: www.health.uct.ac.za/fhs/research/humanethics/forms)

Please quote the HREC REF in all your correspondence.

Please note that the ongoing ethical conduct of the study remains the responsibility of the principal investigator.

Please note that for all studies approved by the HREC, the principal investigator **must** obtain appropriate institutional approval before the research may occur.

The HREC acknowledge that the student, Dr Chimezirl Anderson will also be involved in this study.

Yours sincerely

Signature Removed

PROFESSOR M BLOCKMAN
CHAIRPERSON, FHS HUMAN RESEARCH ETHICS COMMITTEE
Federal Wide Assurance Number: FWA00001637.
Institutional Review Board (IRB) number: IRB00001938
This serves to confirm that the University of Cape Town Human Research Ethics Committee complies to the Ethics Standards for Clinical Research with a new drug in patients, based on the Medical

HREC 736/2016

III Clearance letter from Madagascar

REPOBLIKAN'I MADAGASIKARA

Antananarivo, October, 26th, 2016

MINISTRY OF PUBLIC HEALTH

DIRECTION OF PARTNERSHIP

THE DIRECTOR OF PARTNERSHIP, NATIONAL EYE COORDINATOR

TO

Professor PAUL COURTRIGHT,
Kilimanjaro Centre for Community Ophthalmology

US: 17602 Marymont Place, San Diego, CA 92128

N° 518 - MSANP/DP

Object: Authorization

Dear Professor Paul,

With support from the Kilimanjaro Centre for Community Ophthalmology (KCCO), the Madagascar Ministry of Health and its Partners carried out a programme in 4 regions of the country (Vakinankaratra, Atsinanana, SAVA, and Analmalanga) to identify children with severe visual impairment and blindness using the key informant (KI) method. In each of the regions, KI were trained and deployed to identify children. This exercise was followed by an outreach to the areas to examine those children referred by the KI and to provide service. There is a desire to analyse the findings from the KI work in order for us to better understand KI productivity and the type of eye conditions children present with.

With this letter we are approving the use of the data (with names of children and KI removed) for analysis by Dr. Chimeziri Anderson (UCT Masters student) under your supervision to carry out this analysis.

We are grateful for the collaboration and look forward to working with Dr. Anderson and you on the project.

Sincerely,

Signature Removed

Dr ANDRIAMANJATO Hery Harimanitra
Diplômé de Santé Publique

PART B
LITRATURE REVIEW

Search Strategy

I used the PRISMA method to search and review published articles, online reports, and dissertation works relevant to the topic, the use of key informants for detection of cases of children with eye conditions

Keywords: Blindness, visually impaired, children, childhood, key, informant, screening,

Inclusion: Population-based cross-sectional studies, summaries and reports, ophthalmological and health science related articles, and articles that reported on key informants used for eye care

Databases: Articles identified through PubMed, Science digest, and web of science, grey literature (Google, IAPB, and WHO website) community eye health journal (2007-2017)

Exclusion: Reviews before 2007, abstracts without full test, articles in languages other than English.

Age limit: Excluded articles that recorded children with ages greater than 16yrs

Results: 74 articles (71 journal articles, 1 report and 2 theses) specifically on eye conditions in children and the key informant program were identified. World map (Medscape) and the CIA World Fact Book/ Repository) were used for information on regions and populations of Madagascar

Key Informants for Paediatric Eye Disease Case Finding in Madagascar

2.0 Literature Reviews

Childhood visual impairment describes a number of diseases and eye conditions that occur in children. Most of the more serious disorders can be prevented or avoided by early detection and treatment (Mwende et al., 2005). Globally, it was estimated by World health organization (W.H.O) in 2014 that 19 million children were visually impaired and among this number, 1.4 million children were blind. It was also reported that 50% of blindness in children can be prevented or avoided by early detection and appropriate interventions (Gilbert and Muhit, 2012). 'Over 70% of blind children live in developing countries' (Gilbert, 2009). Some children need visual rehabilitation interventions for a full psychological and personal development (Ishtiaq et al., 2016) (World Health Organization, 2014).

2.1 Economic importance of childhood visual impairment

The magnitude of blindness among children due to cataract may be relatively small compared to adult blindness due to cataract, however, it was reported to be equivalent to the burden of adult blindness due to cataract when analyzed in terms of person-years or quality disability years (HRQoL) (Gilbert, 2009, Gogate et al., 2009, Tran et al., 2011, Tadic et al., 2016).

2.2 Childhood blindness as a priority

Childhood blindness remains a priority for a number of reasons: children who are born blind or who become blind and survive have a lifetime of blindness ahead of them (lifelong disability) (Khandaker et al., 2014), there is a large emotional, social and economic cost to the child, the family, and society (Ahmad, 2010, Demissie and Solomon, 2011). Many of the causes of blindness in children are either preventable or treatable if interventions are applied early. (Bronsard et al., 2008, Congdon et al., 2003, Mwende et al., 2005).

Children are born with an immature visual physiology and for normal visual development to occur, they need clear, fixated images to be transmitted to the visual pathways. Vision loss in childhood has far-reaching implications for the child's development. (Hashmi et al., 2010, Courtright, 2012). There is therefore a high level of urgency for treating childhood eye disease (Gilbert and Foster, 2001, Gogate et al., 2009)

2.3 Causes of childhood visual impairment/blindness

The main causes of blindness in children include: strabismus, corneal opacities (congenital or acquired), cataracts (congenital, developmental, and traumatic), glaucoma, uveitis, retinal pathology which includes; retinopathy of prematurity, retinal detachment, optic nerve pathology, cerebral visual impairment. It would also be important to know that amblyopia (which can result from anything listed above due to the brain "turning off" the affected eye, is a common pathway to decreased vision/ permanent vision loss in children. (Congdon et al., 2003, Gilbert, 2009, Kong et al., 2012, Njuguna et al., 2009)

Vitamin A related and corneal ulcer blindness have been reported to have reduced due to the scaling up of immunization and vitamin A supplementation for children in SSA countries (Courtright, 2012). The control of diseases that cause corneal scarring resides in primary health care, public health interventions, and child survival programmes and there is a need to sustain cost-effective, acceptable interventions at the community and household level for the control of vitamin a deficiency (Gogate et al., 2009, Gilbert, 2001, Courtright et al., 2011)

The causes of blindness in children were further categorized according to the anatomical site of the lesion or according to the disease aetiology. The anatomical site classification refers to the site of the lesion e.g. lens (congenital or developmental cataract), cornea scarring , including traumatic corneal opacity, corneal scarring due to measles infection and vitamin A deficiency (keratomalacia), uvea (uveitis caused by infectious pathogens or inflammatory processes), posterior segment pathologies (choroid, retina or vitreous are sites of glaucoma, retina diseases and other abnormalities like retinal detachment and retinopathy of prematurity. Whole globe diseases/disorders were classified as diseases that affect all the anatomical sites. Optic nerve conditions are affectations to the visual pathway and visual centres of the brain leading to visual field constriction or cortical blindness (Yildiz et al., 2016) (Maida et al., 2008). Aetiological factors describe the specific origin of the abnormality that resulted in blindness, for example, hereditary (genetic), intra-uterine, perinatal and trauma. Others include endogenous and exogenous infections associated with poor sanitation and malnutrition. (Pascolini and Mariotti, 2012, Courtright et al., 2011, Solebo et al., 2017b)

2.4 Pathophysiology of childhood blindness

There are studies from Bangladesh (Negretti et al., 2015), Nigeria (Umar et al., 2015) Tanzania,(Bronsard et al., 2008) Malawi, Kenya, and Ugandan (Msukwa et al., 2009) and Madagascar(Randrianotahina and Nkumbe, 2014a) that suggests that the age of children undergoing cataract surgery is often too high to give the optimal outcome and benefit. Corneal opacity, measles and viral keratitis, ophthalmia neonatorium, the harmful effect of traditional eye medications are on the decrease following specific interventions(Gilbert and Foster, 2001). This has likely led to a greater proportion of blindness in children to be due to cataract.

The consequence of delay in identification, diagnosis and treatment of childhood eye conditions can lead to life-long blindness and cognitive distress.

2.5 Epidemiology of childhood blindness

Studies in sub-Saharan Africa have estimated the prevalence of blindness in children to range from 0.2-0.8 per 1,000 children (Shirima et al., 2009, Courtright, 2012). Studies in high-income countries generally report a lower prevalence ranging from 0.2-0.3 per 1,000 children(Gilbert and Muhit, 2008, Gilbert and Muhit, 2012). Estimates from 25 years ago suggested that the prevalence of childhood blindness in low-income countries ranged from 1.0-1.5 per 1,000 children (Foster and Gilbert, 1992). There are many reasons for the lower prevalence figures in more recent work; study design has improved (estimates are likely more accurate) and vitamin A deficiency blindness has decreased. Along with a reduction in the prevalence of blindness, there have been marked changes in causes of blindness. Corneal lesions were suggested to be the main cause of childhood blindness in Africa and Asia (Gilbert et al., 1999) but corneal blindness in children is much rarer now . Vitamin A supplementation programmes and measles immunization programs in most SSA countries (Courtright, 2012) have contributed. Previously, most data on childhood SVI/BL in children came from examining children in special education (schools for the blind) (Shirima et al., 2009, Mariotti, 2004) or from hospital registries (Courtright, 2012, Gogate et al., 2009) or birth cohort (Solebo et al., 2017a). These methods have been adjudged to work well in countries or regions with strong health systems

2.*6 Standard methods*

There were several existing methods used in study of blindness in children, the table (Table 2.1) presents a summary of them, the advantages and disadvantages of the methods which were referred to as standard methods

Table 2.1: Survey methods ((Solebo et al., 2017a) (Table 1)

Method	Data Type	Advantages	Disadvantages	Challenges
Cross-Sectional Surveys	Prevalence and causes	Reliable estimates of prevalence possible if rigorous methodology	Huge sample size, few blind children identified	Logistics, expensive, need trained survey team
House to House Survey	Prevalence and causes	Reliable estimates of prevalence possible if rigorous methodology	No sampling, data not representative if a limited area	Logistics, expensive, data may not be generalizable
Registers	Incidence and causes	An ongoing routine system	Data is available on those accessing health care only	Need a new and good health system. Strong collaboration of clinicians. under-ascertainment is possible
Birth cohorts	Incidence and causes	Reliable to estimate incidence	Not available in LMIC, poor follow up system	Baseline data from the cohort may not have an eye or vision-related data
Surveillance	Incidence and causes	Reliable to estimate incidence	Data available on those accessing health care	Works well in a good health system
Blind School	Determine causes	Large number of children can be examined quickly and cheaply by single observer	Selection bias, miss preschool children and those with multiple disabilities	There may be no blind school or the blind schools are far away from each other in a country
CBR Programs	Prevalence /causes	Program starts with a survey at inception, not much additional cost and it is followed by services	Not generalizable, Selection bias, method not very stringent	Additional training of CBR staff for eye exam and data collection, multi-disabilities require special skill to examine
Hospital-based Studies	Determine causes	Data can be collected as part of routine information	Information bias and incomplete data, done with multi examiner	Hospital staff may not be interested to take extra duty and some records may not be accessible.
Key Informants	Prevalence and causes	Eliminate false positives, Identify large number proportionate in gender and age, direct and cheap	May combine data with other surveys if children are in blind schools	High dropout rate of KI after training

Population-based prevalence studies of childhood blindness are costly and difficult. A large sample is needed to identify sufficient numbers of children to generate reliable estimates in a cross sectional study. The examination of children in the field is difficult, particularly in infants. (Solebo et al., 2017b, Acil and Ayaz, 2015). Hospital or birth registrars provide data on incidence but need to be an ongoing routine with effective follow up which is logistically not feasible in developing countries. Blind school and CBR surveys are subject to selection bias as children who are not enrolled will be missed out from the estimate.

2.7 key informants

To obtain a more representative population-based sample of children in developing countries, an innovative method was developed for ascertaining severe visually impaired (SVI) or blind (BL) children by training local volunteers to act as key informants (KI'S)(Muhit et al., 2007). Key informants (KI's) in this context are well-known, respected, and peer-selected community members who have an interest in child blindness and eye health(Fact Book, 2001). They are asked to identify children with vision problems and to help them access referral services. Many prevalence of childhood blindness studies have been done using the key informants methods(Ahmad, 2010, Duke et al., 2013b, Bronsard et al., 2008, Kalua et al., 2012, Foster, 2007, Demissie and Solomon, 2011, Kuper, 2010, Xiao et al., 2011) and a standard guideline has been developed for Africa (Shija et al., 2012).

2.8 key informants for population surveys

Studies have documented that in most developing countries only 10% of blind children are in special schools, which characteristically under-represent certain groups such as girls (Gilbert, 2012, Courtright and Lewallen, 2009). A number of Published key informant studies have been done in SSA (Table 2). These includes studies in Ghana(Boye, 2005) Malawi (Foster, 2007), Tanzania ((Shirima et al., 2009) and Nigeria (Muhammad et al., 2010, Duke et al., 2013b, Kuper, 2010, Aghaji et al., 2017). The findings from the Bangladesh study indicated that the children recruited by Ki were likely to be representative of all children with SVI/BL in the community, with similar proportions of female, pre-school age, multiple impaired and rural-based children.(Negretti et al., 2015, Agarwal et al., 2010).

According to a study (Williams and Sparrow, 2007), the number of children assessed by the KIs was nearly double that of the numbers recruited from special and integrated schools or community-based rehabilitation (CBR) programmes combined . The children recruited by the KIs were more likely to have severe visual impairment (SVI) rather than blindness and the cause of vision loss in children identified by KI were 40% and 30% more likely to be avoidable than for children identified in schools for the blind and CBR respectively. The report further documented that children identified by the KI's were more likely to be female, aged 0–5 years, to live in rural areas and have infantile-onset eye problems than children identified by the other methods . Most of the KI's activities were done in a campaign mode that consists of training and sending out the key informants within a given period of time. A summary of published KI studies in SSA, site of the projects in the country, findings and the referenced article is tabulated below (Table 2)

Table 2. Key informants surveys on children in SSA, year and place of the study

Year	Ki Project	Site	Purpose Of Study	Reference
2005	Ghana	Ghana	Prevalence of BL/SVI	(Boye, 2005)
2007	Malawi	Chikwawa	Determine causes of BL/SVI	(Kalua, 2007)
2009	Tanzania	Kilimanjaro,	Prevalence and causes of BL/SVI	(Shirima et al., 2009)
2010	Nigeria	Northwest	Describe the challenges faced by KI	(Muhammad et al., 2010)
2011	Ethiopia	Sekoru district	Determine prevalence and causes BL/SVI	(Demissie and Solomon, 2011)
2012	Malawi	Mulanje,	RCT to compared KIM WITH HAS	(Kalua et al., 2012)
2012	Tanzania	Kilimanjaro and Singida regions,	Compare productivity of KI and dedicated health workers in identifying children with surgical eye care needs	(Shija et al., 2012)
2013	Nigeria	Cross river state	Describe challenges faced by KI	(Duke et al., 2013a)
2013	Nigeria	Cross river state	Determine prevalence and causes	(Duke et al., 2013b, Congdon et al., 2003)
2017	Nigeria	Nsukka(Enugu)	Prevalence and causes	(Aghaji et al., 2017)

2.9 Productivity of key informant's methods for case finding

Productivity and demographic characteristics of KI have been assessed in Malawi, Tanzania, and Nigeria. In Malawi (Kalua et al., 2009), male KI's were 2.7 times more productive than female KI although the community preferred female KI than male KI. In another setting in Malawi (Kalua et al., 2012) the productivity of KI's was compared to that of trained health surveillance assistants

(HSAs); KI’s were found to perform better than HSAs. In an earlier study in Tanzania (Shija et al., 2012), KI's were also found to be more effective at case finding compared to health workers. In Nigeria (Duke et al., 2013a, Kuper, 2010, Duke et al., 2014) KIs were found to have a good understanding of the impact of vision loss in children. The Nigerian study suggested that their training programmes should use ‘existing knowledge of KI, including the social impact of severe vision loss to help them identify children needing assessment’. Challenges faced by KI's in Nigeria included issues related to refusal of the family of the child as well as operational conditions; principally, transportation, communication, and incentives(Duke et al., 2013a).

Duke R. et al, reported on the cost of using KIs. KIs were judged to be less expensive but their ability to detect severe visual impairment or blindness in children, particularly infants, is less rigorous compared to other survey methods.

This research work is based on data from an existing KI programme. It was not possible to carry out a comparison of different approaches to case finding

Further research needs to be done to determine the long-term impact, sustainability and if the key informants could continue to render their services after the campaign (Kalua et al., 2009, Fidler, 2013, Shija et al., 2012, Duke et al., 2014).

3.0 Characteristics of study population.

Madagascar is an east African island nation located south coast of Indian Ocean. It has a population of 25 million, with 11 million children under 15 years old (Amuamuziam, 2015). The country spends only 3% of GDP on health care and is reported to be number 151 out of 187 low-income countries in the UN human development index.(de Jong, 2001, Gaffikin et al., 2007). In a recent study in one remote region, 64% of blindness in adults age 50 years and over was attributed to cataract (Razafinimpanana et al., 2012). Eye care manpower is quite limited with one or two eye surgeons per million populations (Randrianotahina and Nkumbe, 2014b) and eye disease is among most prevalent medical conditions in the country(Razafison, 2008) . Up until 2010, there was no child eye health tertiary facility (CEHTF) in the country as recommended by the World Health Organization (Norris et al., 2009). As of 2014 , there were 60 ophthalmologists in the country (Palmer et al., 2014) but only one pediatric ophthalmologist based at the CEHTF in the capital city, Antananarivo. There were no optometrists, although there were ophthalmic technicians.

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Key Informants for paediatric eye disease case finding

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Abstract

Purpose. Madagascar, with 11 million children less than 16 years old, may have about 200,000 children with visual impairment. The primary aim of this study was to estimate the prevalence and causes of eye conditions among children in Madagascar and to assess the productivity of key informants (KI) in case detection.

Methods. A quantitative cross-sectional approach using data generated from a key informants program in four regions of Madagascar was used. Data from project sites were pooled, analyzed and summarized. Categorical proportions were tested with chi-squares test and subgroup characterization of demographic variables was quantified.

Results. The prevalence of eye conditions among children in the select populations was 2 per 1000 children and severe eye conditions was 0.1 per 10,000 children. About 22% of children with cataract were infants aged (0-5) years but the average age was 7 years. The mean number of children found per KI was four with female KI more productive and more likely to find female children compared to male KI.

Recommendations. There is need for investment by the Ministry of Health and partners in the training of KI and organization of outreach in other regions in the country. This will also require training of eye health providers regarding paediatric eye care.

Key words: Blindness, visually impaired, children, childhood, Key Informants, Screening

Background

Madagascar has a population of about 25 million among whom 11 million (42%) were children less than 16 years. (CIA, 2010) .The country spends only 3% of GDP on health care and is graded 151 out of 187 low-income countries in the UN Human Development Index; 65% of the population are rural dwellers(de Jong, 2001, Gaffikin et al., 2007). In a recent survey, 64% of blindness in adults aged 50 years and over was attributed to cataract (Randrianivo et al 2014). Eye care treatment in Madagascar is primarily provided on a fee for service basis, however many initiatives from NGOs have helped in the cost of treatment for those least able to pay. Eye care manpower is quite limited with one or two eye surgeons per million population (Randrianotahina and Nkumbe, 2014b), and eye disease is among most prevalent medical conditions in the country(Razafison, 2008). Up until 2010, there was no child eye health tertiary facility (CEHTF) in the country as recommended by the World Health Organization, overall, there were 60 active ophthalmologists (Palmer et al., 2014)(Norris et al., 2009) including one pediatric ophthalmologist based at the CEHTF in the capital city, Antananarivo. There are no optometrists, although there are ophthalmic technicians.

A study using calculations from Tanzania suggested that more than 2,500 children are currently living with blindness from non-traumatic cataract in Madagascar.(Nkumbe and Randrianotahina, 2011). Paediatric eye care was initiated in 2010 in one region, Vakinankaratra (Randrianotahina and Nkumbe, 2014a), and was expanded in the following few years to include three other regions. In 2014, these four regional eye care programs carried out training of key informants (KIs) followed by outreach in order to identify children with vision loss, to either provide the service at their facility or ensure that the children were provided services at the CEHTF in the capital city.

According to WHO, blindness is presenting visual acuity of worse than 3/60 in the better eye (World Health Organization, 2014). It can also be assessed in children by other methods (e.g. hand movement, identification of objects and physical examination). Globally, an estimated 19 million children 15 years or younger are visually impaired and 1.4 million of this number are reported to be blind. (Gilbert and Foster, 2001, Mariotti, 2004).

Some individual studies in SSA have estimated that the prevalence of blindness in children in the region ranges from two to eight per 10,000 children (Courtright, 2012a). Although the problem is not large in terms of absolute numbers compared to adults, it is a major issue when considering disability-adjusted life years (Gilbert et al., 1999, Tran et al., 2011). Up to 50% of blindness in children is due to causes that are avoidable or treatable; cataract (congenital and developmental) is likely one of the most important causes of treatable blindness. Blindness due to refractive error is extremely rare but it is a leading cause of visual impairment. As at 2012, 12 million children were reported to be visually impaired due to refractive errors (Bourne et al., 2012). Unlike the adult cataract, there is urgency for detecting and treating cataract in children early due to the poor outcome of a delayed surgical intervention.(Lenhart et al., 2015, Mwende et al., 2005)

Undertaking population-based surveys for children is not simple; the predisposing factors are relatively rare and the condition of blindness among children is not common. This means that large numbers of children will need to be examined to find a few cases (Gogate et al., 2009, Gilbert and Foster, 2001). Another challenge is the technical skill and expertise needed to examine and identify children with vision loss. It is difficult to measure visual acuity accurately in children, particularly when vision loss is associated with other disabilities.(Murthy et al., 2014).

Various methods have been used to identify children with vision loss in developed countries but these are not practical in developing countries. Other tools need to be used to identify children with vision loss in developing countries. About 15 years ago, a unique approach of KI's was used for carrying out surveys of the prevalence of vision loss in children. Muhit et al. were the first to use the "Key informant method "KIM' in a large project in Bangladesh (Muhit et al., 2007). The first published study in Africa was done in Tanzania (Shirima et al., 2009, Bedford et al., 2013, Kalua et al., 2008). Other studies in Africa were done in Ghana (Boye, 2005), Nigeria (Duke et al., 2013, Muhammad et al., 2010, Aghaji et al., 2017, Kuper, 2010) Malawi (Kalua, 2007, Kalua et al., 2012a).

The term key informant (KI) in this context, refers to peer-selected community members who have an interest in children and eye health. They are asked to identify children suspected of having severe visual impairment or blindness and assist them and their parents to attend a special outreach where a proper diagnosis can be made and interventions initiated. KI studies were often done in a campaign mode (i.e. finding cases within a given period of time). The findings from the Bangladesh study indicated that the children recruited by KI were likely to be representative of all children with SVI/BL in the community, with similar proportions of female, pre-school age, multiple impaired and rural-based children.(Negretti et al., 2015).

Based upon the Tanzania and Malawi KI projects, an Africa-focused KI training guideline was developed (Shirima et al., 2009,). The manual documented that KI are more efficient at eliminating false positives, and often refer large number of children for examination.

The productivity of KI was documented in some studies and ranges from two to four children per KI (Kalua et al., 2009, Duke et al., 2013, Duke et al., 2014). A study (Shija et al., 2010) found that KI will identify one to three children /KI. It showed that KI's perform better than formal health workers in identifying children with congenital and developmental cataract. Other studies (Duke et al., 2013, Kalua et al., 2009, Kalua et al., 2012b) suggested that initial perception of KI about blindness in children has a significant impact on their motivation and that incentives do not determine productivity. Du Toit (du Toit et al., 2017) recently published a systematic review of literatures on the 'KIM' and suggested that the KIM is a reliable way to estimate the prevalence of severe eye conditions among children in developing countries .

There has been no published report of KI program in Madagascar; hence the aim of our study was to use the data from the KI project in Madagascar to assess the prevalence of childhood eye disease in the project area and to determine the relative productivity of KI in different setting. It is our expectation that the prevalence of childhood eye disease in Madagascar will be high based on existing reports. We also anticipated from previous KIM reports that male KI will have higher productivity and find more children with severe eye conditions.

Methods

Secondary data analysis was undertaken using records from KI programs in four regions in Madagascar. Data collation was done by KIs using a standardized format after training. It was expected that the KIs will cover the villages in their catchment area, identify children suspected to be blind or with severe visual impairment. KIs kept a register of all suspected children and an outreach was organized to a nearby health facility where all children were either brought or encouraged to be brought for assessment. An ophthalmologist undertook a clinical assessment to confirm any eye condition and identify probable cause. KI registers (which also included information on the eye condition diagnosed by the ophthalmologist) were collected and computerized. The variables that were included on the registers include; age, sex, eye condition, and cataract status of children**.** Only data from KIs in the constituent population areas and for children less than 16 years of age were entered respectively. The four regions were Analamanga, Atsinanana, SAVA, and Vakinankaratra. For each KI, information on age, sex, and number of children identified was recorded.

The KI data were provided with the approval of the Malagasy Ministry of Health. The data which was in MS Excel format was cleaned, stored and patient identifiers removed. Statistical analysis was undertaken with Stata (15.0) statistical software (Stata Corp., College Station, TX, USA). Analyses included assessment of demographic characteristics of the children, causes of blindness and productivity of KI, (average number of children identified per KI). At the time of the program, informed consent was provided by all parents for any services provided and additional ethical approval for the secondary data analysis was provided by the Health Research and Ethics Committee of the University of Cape Town. The Madagascar government has authorized the use of the data for analysis.

Results

The total population of the nine communes was 377,613, among whom an estimated 142,000 were children less than 16 years of age. Out of 1038 children identified by KI, 889 children were seen and examined by the ophthalmologists. Girls outnumbered boys by 3:2 but there was no significant difference in age by sex. The mean age of the children identified was 9 years; the youngest child was 7 months old. The largest age group was school age children (age 6 -11 years) and the number of children seen at the outreach was highest in Analmalanga. (Table 1)

Table 1: Demographic characteristics of the children referred and examined

Variable	**Boys (%)**	**Girls (%)**	**Total %**	**Odds Ratio (95% Ci)**
Total Overall	390(42.3)	499 ((57.7)	889	
0-5 Years	73 (20.86)	87 (17.94)	167(19.16)	1.0
6-11 Years	171(48.86)	224 (47.31)	422(47.31)	0.9 (0.62-1.34) P=NS
12-15 Years	106(30.29)	174(35.88)	300(35.88)	0.7 (0.48-1.10) P=NS
Total	390	499	889	
Region (Children Seen)				
Analmalanga	242(39.3)	374(60.7)	616 (59.4)	1.0
Atsinanana	20 (36.4)	35 (63.6)	55 (5.3)	0.88 (0.49-1.57) P=NS
Sava	37 (48.7)	38 (51.3)	75 (11.3)	1.47 (0.99-2.18) P=NS
Vakinankaratra	71 (49.7)	72(50.3)	143 (13.8)	1.52 (1.05-2.20) P=0.02

NS = not significant

Among the 889 children examined, 755 (84.9%) had one or more eye conditions. (Table 2) There was no difference in the proportion of eye conditions between boys and girls. The oldest age group (12-16) was least likely to have eye conditions. Children examined in Atsinanana were 10 times likely to have eye conditions compared with those in Analmalanga OR =9.7 (95% CI 1.62-395) P =0.02.

Table 2: Eye conditions in children aged <16 years

Variable	Children With Eye Conditions %	Children With No Eye Conditions %	Total	Odds Ratio(95%Ci)
Sex				
Boys	317(85.7)	53(14.3)	**370**	1.0
Girls	438(84.4)	81(15.6)	**519**	0.9 (0.61-1.34)P=NS*
Total	**755**	**134**	**889**	
Age				
0-5 Years	150(89.8)	17(10.2)	**167**	1.0
6-11 Years	360(85.3)	62(14.7)	**422**	0.66 (0.35-1.19) P=NS*
12-15 Years	245(81.7)	55(18.3)	**300**	0.5 (0.26-0.92) P= 0.02
Region				
Analmalanga	522(84.7)	94(15.3)	**616**	1.0
Atsinanana	54(98.2)	1(1.8)	**55**	9.7 (1.62-395) P=0.01
Sava	65(86.7)	10(13.3)	**75**	1.2 (0.57-2.65) P=NS*
Vakinankaratra	114 (79.7)	29(20.3)	**143**	0.71 (0.44 1.17) P= NS*

*NS = not significant

Among the children assessed by the ophthalmologists, the most prevalent eye conditions recorded was conjunctival disease (n=319), followed by refractive error (n=232). These two conditions constituted about 62% of the total record of eye conditions (Table 3). There was no difference in eye conditions by sex and refractive errors were least common among the youngest age group.

Table 3: Eye conditions by age and sex and residence

Variable	Conjunctival%	Refractive Error %	Cataract %	Glaucoma%	Retinoblastoma	Others %	Normal Eye %	Total
Sex								
Boys	141(38.1)	85(23.0)	8(2.2)	1(0.2)	0(0)	82(22.2)	53(14.3)	370(41.6)
Girls	178(34.3)	147(28.3)	11(2.1)	2(0.4)	1(0.2)	99(19.1)	81(15.6)	519(58.4)
Age								
0-5 Years	83(49.75)	25 (15.0)	4(2.4)	0(0)	1(0.6)	37(22.2)	17(10.2)	167
6-11 Years	149(35.3)	124(29.4)	11(2.6)	2(0.5)	0(0)	74(17.5)	62(14.7)	422
12-15 Years	87(29.0)	83(27.7)	4(1.3)	1(0.3)	0(0)	70(23.3)	55(18.3)	300
Region								
Analmalanga	273(44.3)	184(29.9)	1(0.2)	2(0.3)	0(0)	62(10.1)	94(15.3)	616
Atsinanana	14(25.5)	26(47.3)	5(9.1)	0(0)	0(0)	9(16.4)	1 (1.8)	55
Sava	16(21.3)	17(22.7)	8(10.6)	1()	0(0)	23(30.7)	10(13.3)	75
Vakinankaratra	16(11.2)	5(3.5)	6(4.2)	0()	0(0)	87(60.8)	29(20.3)	143

The estimated prevalence of non-severe eye conditions was 2 per 1000 children (n=732/337,613). This estimate ranges from 0.1-4 per 1000 children from the different regions. There was no significant difference by sex. Cataract, glaucoma and retinoblastoma were considered severe eye conditions. The prevalence of severe eye conditions was 0.1 per 10,000 children (n=23/337,613). Among children brought for assessment, those in Sava were 29 times, children in Atsinanana were 18 times, and children in Vakinankaratra were 10 times more likely to have severe eye condition compared to children brought by KI in Analmalanga. (Table 4)

Table 4: Severe and non-severe eye conditions in children

Variable	Eye Conditions Severe 3 (%)	Eye Condition Not Severe 97 (%)	Total	Odds Ratio(95% Ci)
Sex				
Boys	9(2.8)	308(97.2)	317	1.0
Girls	14(3.2)	424(96.8)	438	1.1 (0.45-3.00) P=NS
Age				
0-5 Years	5(3.3)	145(96.7)	150	1.0
6-11 Years	13(3.6)	347(96.4)	360	1.1(0.36-3.96)P=NS*
12-15 Years	5(2.0)	240(98.0)	245	0.6 (0.14-2.68) P=NS*
Region				
Analmalanga	3(0.6)	519(99.4)	522	1.0
Atsinanana	5(9.3)	49(90.7)	54	17.7 (3.28-116)P=0.00
Sava	9(26.9)	54(83.1)	65	28.8 (6.85-168)P=0.00
Vakinankaratra	6(5.3)	108(94.7)	114	9.6(2.00-60.0)P=0.00

*NS = not significant

The overall productivity of KI across the programs was four children per KI (n=862/221). There was no information on 27 children not brought by KI. Female KI brought more children (4/KI) compared to male KI (2/KI) (Table 5). Female KIs were 1.6 times more likely to identify female children compared to male KI. Compared with male KI, female KIs were more likely to refer children in Vakinankaratra (OR=4.85, 95% CI 2.84-8.19, p=0.00) and SAVA (OR=1.91, 95% CI 0.99-3.68, p=0.07) than male KI in Analmalanga. Female KI, who made up 76% of KI, found 88% of the children with cataract and glaucoma.

Table 5: Productivity of KI

Variables (Children Brought)	Male Ki N= 52 (#/KI)	Female Ki N= 169 (#/KI)	Total %	Odds Ratio (95% Ci)
# Of Children Brought	111(2.14)	751 (4.44)	862(3.90)	
Sex				
Boys	58 (1.11)	303 (1.79)	361(1.63)	
Girls	53 (1.02)	448 (2.65)	501(2.27)	1.62 (0.06-2.46)P=0.02
Age Categories				
0-5 Years	18 (0.35)	146 (0.86)	164(0.74)	1.0
6-11 Years	53 (1.02)	354 (2.09)	406(1.84)	1.23 (0.68-2.31)P=NS*
12-15 Years	39 (0.75)	250 (1.48)	292(1.32)	1.14 (0.60-2.22)P=NS*
Region				
Analmalanga	60 (1.15)	556(3.29)	616(2.79)	1.0
Atsinanana	0 (0)	30 (0.18)	30 (0.14)	0.0
Sava	13(1.6))	63 (0.37)	76 (0.34)	1.91 (0.99-3.68)P=0.07
Vakinankaratra	33(4.0)	105(0.62)	138(0.62)	4.85 (2.84-8.19) P=0.00
Children Brought With:				
Conjunctival Condition	43 (0.83)	270 (1.60)	313(1.42)	
Refractive Error	19 (0.37)	204 (1.21)	223(1.00)	
Cataract	2 (0.04)	12 (0.71)	14 (0.06)	
Glaucoma	0 (0)	3 (0.02)	3 (0.01)	
Other Conditions	32 (0.62)	142 (0.84)	174(0.79)	
Normal Eye	14 (0.27)	119 (0.70)	135(0.61)	
Children With Eye Conditions	96 (1.84)	631 (3.73)	727(3.29)	
Children With No Eye Conditions	14 (0.27)	119 (0.71)	135(0.61)	0.78 (0.400-1.45)P=NS

*NS = not significant

Discussion

The overall estimated prevalence of eye conditions among children in these four regions in Madagascar was about 2 per 1000 suggesting that a minimum of 50,000 children in Madagascar may have one or more eye conditions. The estimate could be as high as 200,000 children if findings from Analmalanga are more representative of the country. The prevalence of severe eye conditions (primarily cataract) was 0.1 per 10,000 suggesting that approximately 250 children in Madagascar have serious eye conditions. This estimate varies greatly across the regions. In Analmalanga, which surrounds the country's capital city, only one cataract case was identified while in Sava region, there were nine cataract cases (0.1 per 1000). Nkumbe (Nkumbe and Randrianotahina, 2011) suggested that 2500 children may be blind in Madagascar in 2011. Nkumbe's estimate is consistent with the upper limit of our findings and our expectations from this analysis. General eye care and paediatric eye care services have been in place in Analmalanga longer than the other regions; furthermore, Analmalanga is the most urbanized region. This may explain the low number (and proportion) of severe eye conditions in this population compared to the other regions.   (Randrianotahina and Nkumbe, 2014b, Razafinimpanana et al., 2012).

A mean age of children who have cataract was nine years. This suggests that delayed presentation remains a problem and agrees with previous reports in Tanzania (Mwende et al) and Madagascar (Razafinimpanana et al., 2012), which found a mean age of seven years for children operated for cataract between 1999 -2009. Late presentation for cataract surgery results in poor outcomes; late presentation has been attributed to lack of awareness among community and parents that cataract in children should be treated early. Other reasons for late presentation includes inability of the primary health care workers to identify and take adequate follow up measures, inability of health care workers to engage parents and community interactively to prioritize visual impairment in children and inaccessibility to child eye care facility (Mwende et al., 2005).

The overall KI productivity of four children/ KI was consistent with findings in Malawi 2009 (Kalua et al., 2009) which also documented a productivity of four children /KI. The KI manual for Africa suggests that the average number of children identified per KI is likely to be one to three (Shija et al., 2010). We found that female KIs were more productive than male KIs and more likely to identify and refer female children. This finding is at variance with our expectation and with the report from Malawi which recorded that male KI's were more likely to identify blind children and have higher productivity. Female KI's which made up 76% of the KI population in this analysis identified 88% of children with severe eye conditions.

In this population, about 22% of children with cataract were infants aged (0-5 years) which is a priority group for intervention. The ability of the KI's to identify children with cataract and bring more infants attest to how effective and efficient the KI method can be, even in difficult environments.

The strength of this analysis was that all programmes used the same training manual and training plan. In each region all of the children were examined by the same ophthalmologist. All regional plans sought to cover the catchment areas of the programs as completely as possible. There are a number of limitations however; KIs received very limited training and detecting vision loss in very young children can be challenging. At the time of the clinical examination by the ophthalmologists visual acuity was not recorded. In all regions the selection of the area for the case finding was based upon local characteristics such as proximity to the hospital, presence of a health centre for the outreach, interest by health authorities and workers, etc. Accordingly, the areas selected in each region may be different region by region in some unknown way.

The successful deployment of trained KI could be undertaken in other regions in the country where eye care services for children are available. Where eye care services for children are not available, training of eye health providers regarding paediatric eye care would be needed. Additionally, training of KI, organization of outreach, and funding for activities would need to be undertaken. All of these require an investment in human and financial resources by the Ministry of Health and partners.

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Appendix
Journal guideline

Journal Guidelines for Middle East & Africa Journal of Ophthalmology

Journal Manuscript Preparation

Review Articles: Include a summary of (not more than 250 words) in unstructured paragraph form. Abstracts have no reference numbers and should avoid abbreviations.

Case Reports: Include a summary (not more than 150 words) in in unstructured paragraph form. Abstracts have no reference numbers and avoid use of abbreviations.

Introduction: A brief introductory statement should state the objective and intent for presenting this information. This should not include exhaustive review of the literature but only that portion which is pertinent to the purpose of the study.

Material and Methods: Describe precisely and clearly how and why as if to be replicated. In studies of diagnostic accuracy, the methods should include the inclusion and exclusion criteria of the patients involved in the study as well as disclosing the methods of recruitment. Include a statement on IRB/EC approval, and, indicate whether or not the study adheres to the tenets of Declaration of Helsinki. The journal reserves the right to ask for proof of IRB approval.

Results: Clear presentation of all findings in a logical manner.

Use of statistical and mathematical analyses, combined with tables and figures to show results.

Discussion: Comments should be elucidated from the results and limited to significance of the data. Limit the word count to a maximum of 1000 for original articles. Conclude the discussion with a summary of the paper.

Avoid using sub-titles and bullet text in all sections.

Acknowledgements, if any, should be included in the First Page/Title Page file and not in the main Article file.

References should be cited consecutively in the text with superscript numbers. Follow the Vancouver Style for references. The author is responsible for complete and accurate references. Where previous studies are mentioned in a table the author's names should appear in Vancouver style, with the names and reference numbers appearing in one column, and any other necessary information appearing in a separate column. All authors up to 4 will be accounted for. References to journal articles should include, in this order: (1) authors, (2), title, (3) journal name (as abbreviated in Index Medicus, if not included in Index Medicus journal title should be stated completely (4) year, (5) volume, (6) inclusive page numbers. Examples:

Tables should be self-explanatory and should not duplicate textual material.