National Survey of Blindness, Visual Impairment, Ocular Morbidity and Disability in Sri Lanka

A Report (2014-2015)

Vision 2020 secretariat, Ministry of Health Sri Lanka

International Centre for Eye Health Department of Clinical Research,

Faculty of Infectious & Tropical Diseases,

London School of Hygiene & Tropical Medicine, London, UK

Message from
Director General of Health Services

I am honored to write this message for the report of the National Survey of Blindness in Sri Lanka. This is the first national level blindness survey done in Sri Lanka with representative samples from all the districts. Vision 2020 Secretariat of the Ministry of Health together with College of Ophthalmologists of Sri Lanka, Sightsavers, CBM and International Centre for Eye Health London planned, implemented and concluded the survey successfully. In addition to the above mentioned organizations, Department of Census and Statistics, The Ethics Committee of the Faculty of Medicine Colombo, Provincial and District Health and administrative officials all over the country also supported this venture.

The data gathered were analyzed and the results will be more useful for the future planning activities of the Vision 2020 Programme in Sri Lanka and these findings will be very much useful at the regional and global level too. This survey has been carried out seven years after the commencement of the Vision 2020 National Programme and ahead of third five year plan. Therefore I believe these findings will be a good baseline for the next five year plan in delivering eye care services in Sri Lanka.

I would like to appreciate the invaluable contributions of all the parties of the National Survey, and sincerely hope that they all will get together in supporting development of eye care services in Sri Lanka.

Dr Palitha Mahipala
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Funding

Funding for this survey was provided by Sightsavers
with additional contributions from CBM (disability component)

COLLABORATING INSTITUTIONS

Institution / organization In Sri Lanka	Principal responsibilities
Ministry of Health, Colombo, Sri Lanka	Initiated the survey. Chair of Steering Committee
The Sri Lanka National Program for Prevention and Control of Avoidable Blindness (NPPCAB)	Government institution responsible for the co-coordinative planning and implementation of eye care programmes in Sri Lanka.
Sri Lanka VISION 2020 Secretariat	Logistical and technical support during the survey. Dissemination of the findings. Secretariat for National Blindness Survey (NBS) Steering Committee.
College of Ophthalmologists	Professional body responsible for training of ophthalmologists in Sri Lanka and for accreditation. Members of NBS Steering Committee.
Sightsavers Sri Lanka Country Office, Colombo	Financial support for the survey. Assistance in recruitment survey teams, logistical and monitoring. Dissemination of the findings. Use of findings in support of eye care. Member of NBS Steering Committee
CBM Country Office Colombo	Financial support for the survey. Member of NBS Steering Committee
International:	
South Asia Centre for Disability Inclusive Development, Indian Institute of Public Health, Public Health Foundation of India, Hyderabad, Andhra Pradesh, India	Academic institution supporting public health approaches to disability inclusive development in South Asia. Technical support to all aspects of the survey, data analysis, interpretation and writing up. Member of NBS Steering Committee
International Centre for Eye Health London School of Hygiene and Tropical Medicine, Keppel Street, London WC1E 7HT, UK	Technical guidance for the survey design, team training, external supervision of the survey activities, data analysis and report writing. Member of NBS Steering Committee
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CBM South Asia Regional Office 140 Commerce Cube, 2nd floor, 5th Main, Putannachetty Road, Chamrajpet, Bangalore, India - 560018 Forus Health #2234, 23rd Cross, Banashankari	International non-governmental development agency supporting services for persons with disability. Financial support for disability component of the survey. Setting up equipment for the survey, and training survey teams in packing, unpacking and transporting equipment; care of equipment, maintenance and simple repairs.

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On behalf of the Ministry of Health, Vision 2020 Secretariat would like to recognize valuable contributions of different organizations and individuals for the National Blindness and Disability Survey of Sri Lanka. Various governmental and non- governmental organizations and individuals have given their support at different stages of the survey. Without them this would not have been a success. Following are the parties which need specific appreciation:

- Ethics Committee of the Faculty of Medicine, University of Colombo for granting ethical approval,
- Department of Census and Statistics of Sri Lanka (specially sampling and cartography sections) for sampling, mapping and technical advices.
- District and Divisional Secretaries of all districts for organizing local officials, facilitating the survey locations and ensuring efficient participant influx.
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- Medical Officers of Health for motivation of their teams to assist survey teams.
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- Director and staff of the National Eye Hospital, Colombo for providing space and time for training of teams and meetings of the survey committee.
- Director of National STD AIDS Control Programme and Auditor Gen providing office space.
- Survey managers Dr Sunil Settinayake and Dr Nimal Edirisinghe for the efficient work and the two medical officers, optometrists, enumerators, interviewers, project officers, data entry operators and drivers for the tireless hardwork at field level.
- Staff of Vision 2020 Secretariat, Nisansala, Rashomi and Tharanga for the volunteer support they have given.

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LIST OF ABBREVIATIONS

ARMD:	Age Related Macular Degeneration
BCVA:	Best corrected visual acuity
BMI:	Body Mass Index
BP:	Blood Pressure
CI:	Confidence Interval
CSC:	Cataract Surgical Coverage
ETDRS:	Early Treatment of Diabetic Retinopathy Study
GNI:	Gross National Income
HDI:	Human Development Index
ICEH:	International Centre for Eye Health
ICF:	International Classification of Functioning
IMR:	Infant Mortality Rate
INGO:	International Non-Government Organizations
IOL:	Intra Ocular Lens Implant
LSHTM:	London School of Hygiene & Tropical Medicine
MoH:	Ministry of Health
NGO:	Non - Governmental Organizations
NPL:	No Perception of Light
NPPCAB:	Sri Lanka National Program for the Prevention & Control of avoidable Blindness
OR:	Odds Ratio
PCO:	Posterior Capsular Opacification
PL:	Perception of Light
PPS:	Population proportionate to size
PSC:	Project Steering Committee
PVA:	Presenting Visual Acuity
SEAR:	South East Asia Region
SES:	Socio Economic Status
SVI:	Severe Visual Impairment
UNCRPD:	United Nations Convention on the Rights of Persons with Disabilities
UNDP:	United Nations Development Program
VF:	Visual Functioning
VI:	Visual Impairment
WG:	Washington Group
WHO:	World Health Organization

CONTENTS

EXECUTIVE SUMMARY

The National blindness, visual impairment and disability survey in Sri Lanka is the first ever national level study on blindness and visual impairment in Sri Lanka. A survey of self-reported eye complaints of the preceding month and self-reported disability at household level was also embedded within this survey. The survey was designed in 2012; the field work took place in 2013-2014; and the data analysis was completed in 2014-2015. The funding for the survey was provided by Sightsavers with additional contributions from CBM to the disability component.

Survey of blindness and visual impairment (aged 40 years and above)

Methods

The sample size for the survey included 6800 persons aged 40 years and above to estimate the prevalence of blindness and visual impairment across the country in 68 clusters. All 9 provinces and a random sample of divisional secretariats were included, using population proportionate to size cluster random sampling. A total of 3392 households contributed 12,631 individuals of all ages (for disability and ocular morbidity components) and 6713 individuals aged 40 years were recruited for detailed eye examination.

Two dedicated teams were recruited for the survey who examined participants at examination sites set up in each cluster. Each team had a trained ophthalmologist, two optometrists and a team of supervisors, interviewers and enumerators. A survey coordinator led the two teams. All members of the team were trained by staff with expertise in large scale surveys from the International Centre for Eye Health, Department of Clinical Research, London School of Hygiene & Tropical Medicine. Vision2020 Coordinators (community ophthalmologists) and ophthalmologists from the Sri Lanka College of Ophthalmologists provided technical support through monitoring visits to the clusters at periodic intervals. The Sightsavers Sri Lanka country office provided logistical support.

All participants were interviewed to ascertain their past ocular and general history, underwent visual acuity measurement, were refracted, had their height and weight measured, and had an eye examination. All with a visual acuity of <6/12 (< 20/40) in one or both eyes, and where an abnormality was detected had a detailed examination by an ophthalmologist who determined the cause of visual loss.

Findings

The overall response rate was 86.1%. More women than men were examined which may have introduced an element of bias although this is also likely to reflect the greater gap in life expectancy between males and females in Sri Lanka compared to other low and middle income countries and migration of males of working age group outside their home towns.

Prevalence of blindness and visual impairment: World Health Organization categories of visual impairment were used. The prevalence of blindness among those aged 40+ years was 1.7% (95% CI: 1.3 –1.99). The highest prevalence of blindness was in Uva, Eastern, North Western and Northern provinces with the lowest being in the Western and Southern provinces. The prevalence of severe visual impairment among those aged 40+ years was 1.6%, being 15.4% for moderate visual impairment. After adjusting for the different socio-demographic factors, increasing age and poor literacy status were significantly associated with higher levels of blindness.

Causes of blindness and visual impairment: Cataract was the commonest cause of blindness (66.7%) followed by uncorrected refractive errors (12.5%). 6.3% continued to be blind following cataract surgery, mostly due to treatable causes like PCO and Pseudoaphakia with uncorrected refractive error. Uncorrected refractive errors were the commonest cause of mild, moderate and severe visual impairment followed by lens opacities.

Visual outcome after cataract surgery: 6% of participants reported having undergone cataract surgery in one or both eyes. Among the 486 cataract operated eyes, 93.8% underwent IOL surgery. The majority (72.8%) had accessed cataract surgery in Government facilities. Using presenting visual acuity, 59.7% had a good outcome (6/18 or better), 28.2% had a borderline outcome (6/18-6/60) while 12.1% had poor outcomes after cataract surgery. These figures improved to 75.1%, 16.1% and 8.8% with correction.

Cataract surgical coverage (CSC): Coverage was 85.4% at the 3/60 cut off level at the person level (Table 22). This means that 85% of bilaterally cataract-blind individuals have undergone surgery. CSC was significantly lower at older ages, among those with poorer literacy, lower economic status and those residing in North West, Uva and Central provinces in Sri Lanka.

Visual functioning: Visual functioning was assessed among those who were blind due to cataract or uncorrected refractive errors, and those previously operated for cataract. Except in near vision tasks, where there no statistically significant differences between the three groups, statistically significant differences were observed in all other domains. Cataract blind persons had the worst visual functioning while those who had undergone cataract surgery had far better outcomes in all domains.

Barriers to service access: Barriers to accessing eye care services were elicited from those who were severely visually impaired or blind individuals from cataract and uncorrected refractive errors. Expenses related to treatment followed by family responsibilities/obligations were the commonest reasons cited. Perceived barriers were more common among the cataract blind/severely visually impaired compared to those impaired due to uncorrected refractive errors.

General health: More than half the participants had normal nutritional status (Table 12), while 6% were obese. Only 13.8% stated that they knew that they were diabetic, 82% of whom were on medication. Only a quarter of the known diabetics reported that they had ever undergone an eye examination in the past. Nearly a fifth stated that they were hypertensive, 85.9% of whom were on anti-hypertensive medication. On examination 42.1% of participants aged 40 years and above were hypertensive (>140/≥100 mm Hg). The prevalence of hypertension increased higher among males than females.

Ocular morbidity and treatment preferences: 90% of participants reported that they had experienced an eye problem in the preceding month. Diminished vision either for near or distance was the commonest complaint. Less than a third (31.4%) sought treatment for the eye problem. The main reasons for not accessing services were that the condition was not considered serious and lack of finances. The mean total expenditure on health in the preceding month was 12.37 US$.

Disability survey

The prevalence of disability was assessed by administering the Washington Group (WG) Disability Questionnaire (short version) (WG) to the household head of all enumerated households, to obtain self-reported data on all ages.

Prevalence of disabilities: The all-age prevalence of disability was 3.17 [95% CI: 2.87 – 3.50] which increased significantly with increasing age. The prevalence was also significantly higher in females than males, among those in the lower socio-economic strata compared to the higher economic strata, rural residents and Christian populations. There were no differences by ethnicity.

Impact of disability: Difficulty in mobility followed by difficulty in seeing were the commonest disabilities reported by respondents. Activity limitation was assessed only for individuals aged 18 years and above. Problems in joining community activities were the commonest issue highlighted by persons with disability. The loss of dignity due to the behaviour of peers was of immense concern to persons with disabilities.

INTRODUCTION

The Democratic Socialist Republic of Sri Lanka has an estimated population of 21.273 million (2013). The Gross National Income (GNI) per capita was US$9,470 in 2013. The country has excellent health indicators and leads the South Asia Region in all health status indicators. Sri Lanka is situated off the southern coast of India. It lies between Northern latitudes 5°55' and 50°9' and Eastern latitudes 79°42' and 81°52'.

Sri Lanka's Human Development Index value is 0.750 (2013), which i development category. Sri Lanka is ranked 73rd among 187 countries for whom HDI values have been computed [1]. Compared to its neighbours, Sri Lanka has significantly better human development indicators (Table 1). However, Sri Lanka has one of the fastest ageing populations in the entire South Asia region [2] which has led to a rapid transition in disease profile from a predominantly communicable diseases to non-communicable diseases.

Table 1: Comparison of Human Development Indicators in some South Asian countries

Country	HDI value in 2013	HDI rank	Life expectancy at birth	Mean years of schooling	GNI per capita (US$)
Sri Lanka	0.750	73	74.3 years	10.8 years	9250
India	0.586	135	66.4 years	4.4 years	5150
Pakistan	0.537	146	66.6 years	4.7 years	4652

Ref: UNDP Human Development Report 2014 [1].

Sri Lanka has 9 administrative provinces which are further divided into 25 districts, spanning a total area of 62,705 km^2[3]. The Western Province is the most populated and the Northern Province is the least populated (Table 2). The districts are divided into 331 Divisional Secretary areas. The crude birth rate is 17.5/1000 population, crude death rate is 6/1000 population, Infant mortality rate (IMR) is 9.7/1000 live births and literacy rate is 95.6% in the adult population [3]. There is a significant difference in life expectancy between males (70.5 years) and females (79.8 years). This will mean that there will be significantly more surviving women in older age groups than males. Most of the population resides in rural areas (77.3%) while 18.3% reside in urban areas and 4.4% in estate areas.

Figure 1: Administrative Provinces of Sri Lanka

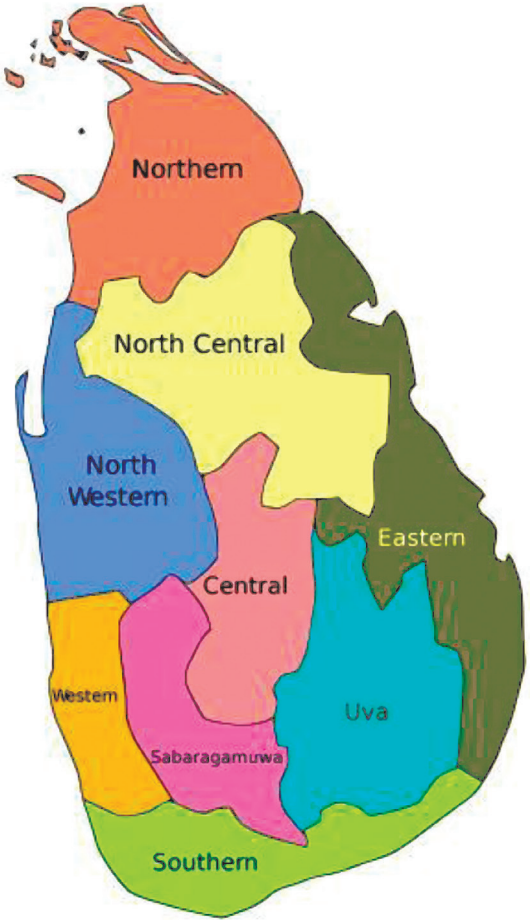


Table 2: Population distribution across the Administrative provinces (Census 2012) [4]

Province	Capital	Area (Km2)	Population	Districts
Western	Colombo	3684	5,851,130	Colombo; Gampaha; Kalutara
Central	Kandy	5674	2,571, 557	Kandy; Matale; Nuwara Eliya
Southern	Galle	5544	2,477,285	Galle; Hambantola; Matara
North Western	Kurunegala	7888	2,380,861	Kurunegala; Puttalam
Sabaragamuwa	Ratnapura	4968	1,928,655	Kegalle; Ratnapura
Eastern	Trincomalee	9996	1,555,510	Ampara; Batticaloa; Trincomalee
North Central	Anuradhapura	10472	1,266,663	Anuradhapura; Polonnaruwa
Uva	Badulla	8500	1,266,463	Badulla; Moneragala
Northern	Jaffna	8884	1,061,315	Jaffna; Kilinochchi; Mannar; Mullaitivu; Vavuniya
Total			**20,359,439**	

Health system in Sri Lanka

Health institutions are under the regulation of the Ministry of Health (MoH) and Provincial Councils. Curative health services are delivered by secondary and tertiary level institutions across the island which are strengthened by an exemplary network of primary care centres under the Department of Health Services.

Eye care service provision

The government public sector provides free eye care to the nation. The "Vision 2020" country program was launched through College of Ophthalmologists of Sri Lanka and MoH and covers five main programmes[5]. They are cataract, glaucoma, childhood blindness, diabetic retinopathy, refractive errors & low vision services.

Global magnitude of blindness, visual impairment and disability

Effective programs for public health priorities including blindness and disability need evidence to support a specific course of action. It is also necessary that this data should be contemporary and not historical if it is to be of use for planning.

In 2010, the World Health Organization (WHO) estimated the prevalence and causes of blindness for the 6 WHO regions [6]. 53 surveys from 29 countries were used to generate these estimates. For the South East Asia region of the WHO, survey data was available from Bangladesh, Democratic Republic of Timor Leste, India, Indonesia, Myanmar and Nepal. There was no data source which was included from Sri Lanka.

The World Health Organization estimated that there were 285 million people who were visually impaired world-wide (39 million blind and 246 million moderate/severe visual impairment)[6]. Globally, the principal causes of visual impairment were uncorrected refractive errors (43%) and cataract (33%). Cataract (51%), followed by glaucoma (8%), age related macular degeneration (ARMD) (5%), childhood blindness (4%), corneal opacities (4%), uncorrected refractive errors (3%) and trachoma (3%) were the commonest causes of blindness.

Compared to blindness, evidence for disability is even rarer. This is because of the wide variation in the definitions of disability. Most of the evidence relates to an 'impairment' but not how the society places barriers to persons with disabilities attaining their full potential. In 2006, the United Nations

Convention on the Rights of Persons with Disabilities (UNCRPD) set out a framework which is now being used to define disability. The WHO highlighted in the World Report on Disability (2010) that disability should not be viewed purely from a medical perspective and suggested that the International Classification of Functioning (ICF) should be the basis for defining disability [7]. Using data from 59 countries (as part of the World Health Survey [2002-2004]), WHO estimates that the prevalence of disability among those aged 18 years and above is 15.6% [7]. The prevalence for adults with very significant disabilities was 2.2%. The prevalence was highest among women, those residing in rural areas and those in the poorest segment of society.

Magnitude of blindness, visual impairment and disability in South East Asia

The WHO SEAR Office has published estimates of disability in the region [8]. The highest estimates for the South East Asia region are for Indonesia (21.3%) and the lowest for Timor-Leste (1.5%). These were collated from available documents in each country. The estimates for Sri Lanka are from the 2001 Census where the prevalence of disability was estimated at 2.0%[8]. There are wide variations in the definitions used in the different studies in the region and therefore the estimates are not comparable.

A number of population-based studies have been undertaken in the South Asia Region to estimate the prevalence of blindness and visual impairment (Table 3).

Rationale for the survey

There is a paucity of evidence on blindness, visual impairment and ocular morbidity at the national level. Population-based estimates are only available from one survey in the Kandy area [19] which reported the prevalence of blindness and visual impairment, based on best corrected vision, to be 1.1% and 5.9% respectively among the population aged 40 years and above [19]. There has been no other population-based study in Sri Lanka.

In the absence of data from Sri Lanka, evidence from other countries in the region has been used to estimate the magnitude in Sri Lanka. This will not be an accurate estimate as blindness and visual impairment are strongly correlated with the eye care service delivery in a country as well as levels of socio-economic development and education, both of which are high in Sri Lanka.

Sri Lanka is a signatory to VISION2020 and has developed national plan in the year 2007 for achieving the goal of elimination of avoidable blindness by 2020. For effective monitoring and evaluation of the inputs for VISION2020, it is imperative that data be available to identify specific challenges that need to be addressed.

The variability in the prevalence of blindness across the different studies in the region means that each country/region will need to derive its own estimate based on national requirements as the prevalence of blindness is likely to be influenced by the age-structure of a population, exposure to risk factors, life expectancy and access to and uptake of eye care services. A national plan in the year

Table 3: Prevalence of blindness and visual impairment in South and South East Asia region

Country	Year	Region	Sample	Age	Prevalence %	VA cut off	Ref
Bangladesh	2001	National	11,624	30+	1.53	<3/60 PVA	9
India	2000	Tirunelveli, Tamil Nadu	5411	50+	4.1 3.0	< 3/60 PVA < 3/60 BCVA	10
India	2000	Andhra Pradesh	3225	40+	7.6	<3/60 PVA	11
India	2001	15 States	63,000	50+	5.34	< 3/60 PV	12
India	2003	Chennai	3924	40+	19.2	< 3/60 PVA	13
India	2009	Navsari, Gujarat	4738	50+	4.3	< 3/60 PV	14
Myanmar	2005	Meiktila, Mandalay	2073	40+	8.1	< 3/60 PVA	15
Nepal	2006	Lumbini	5138	50+	2.3 1.7	< 3/60 PVA < 3/60 BCVA	16
Nepal	2009	Bhaktapur	4003	40+	0.43 0.73	< 3/60 BCVA < 3/60 PVA	17
Pakistan	2004	National	16,507	30+	2.7 3.4	< 3/60 BCVA < 3/60 PVA	18
Sri Lanka	2008	Kandy	1375	40+	1.1	< 3/60 BCVA	19

Purpose of the survey

Vision 2020 Sri Lanka National Program for the Prevention and Control of Avoidable Blindness (NPPCAB) realized the importance of population-based data for evidence based eye care planning as a country-wide blindness survey had never undertaken before. Such data facilitates the effective use of existent resources (human, financial, infrastructure and equipment) targeting the major avoidable causes of blindness in order that the goals of VISION2020 can be achieved in Sri Lanka. To assist in planning an in-depth analysis of the results of the survey on prevalence and causes of blindness was carried out in order to identify the patterns and distribution of eye diseases:

- nationally
- by province
- by rural / urban residence, and,
- by socio-economic and demographic variables (gender, age, literacy, etc).

AIMS AND OBJECTIVES

Overall Aim

To determine the magnitude and causes of blindness and visual impairment, in order to provide data for planning VISION2020 implementation towards elimination of avoidable blindness in Sri Lanka.

Specific objectives of the survey:

1. To estimate the prevalence, magnitude and cause of visual impairment and blindness in individuals aged 40 years and above in a nationally representative sample
2. To determine risk factors for blindness and visual impairment, and functional low vision from the major causes (including the impact of poverty).
3. To determine the prevalence and types of ocular morbidity in the study sample, and to investigate health seeking behaviour among those aged 40 years and above, including expenditures on health.
4. To determine the prevalence and type of refractive errors, spectacle coverage and barriers to accessing services
5. To obtain information on cataract surgical services (i.e. cataract surgical coverage, visual outcomes of different cataract surgical techniques etc.) and to assess risk factors for not accessing services
6. Assess the impact of blindness and visual impairment on quality of life and visual functioning among people with visual impairment and blindness in comparison to those who are not affected
7. Identify health seeking behaviour and barriers to the uptake of services by those who require medical, surgical or optical interventions or low vision services.

In addition

8. To estimate the prevalence and causes of disabilities (other than visual impairment) in survey participants and all family members living in enumerated households.
9. To determine the magnitude of blindness and other disabilities among other family members (all ages and gender disaggregated).
10. To assess costs of treatment and health related expenditure in relation to blindness and other disabilities.

SURVEY OF BLINDNESS AND VISUAL IMPAIRMENT

a. METHODOLOGY

Sampling and sample size estimations

The survey recruited a nationally representative sample of adults aged ≥40 years to estimate the prevalence of blindness while an all age sample was recruited to estimate the prevalence of disability. All the 9 provinces and 25 districts were included.

Sample size:

The study primarily covered population aged ≥ 40 years in Sri Lanka to estimate blindness and visual prevalence. This age cut-off was based on previous data which showed that 75% of blindness and visual impairment occur above the age of 40 years. Districts were used as the primary sampling units. Cluster sampling using proportionate to size (PPS) procedures were adopted to identify a nationally representative sample. This meant that the more populated districts had a larger number of participants. The nationally representative sample was large enough to l provide estimates for five age groups and gender-specific estimates. In addition, the sample size was increased to provide valid estimates for some bigger provinces in the country.

In the absence of adequate data on the prevalence of blindness and visual impairment from Sri Lanka, available evidence from the South Asia region was used for the sample size calculation. The following parameters were used:

Prevalence of blindness (presenting vision) among those aged ≥40 years:	2.5%
Confidence interval:	95%
Allowable error:	0.02
Precision:	80%
Design effect:	1.5
Response rate:	85%
Age strata:	4
Sex strata:	2
Residence strata:	2

Using these parameters, the sample size to be recruited was 6,600. This accounts for a response rate of 85%, and the number was rounded off. This sample would provide accurate estimates for the national magnitude of blindness and visual impairment, including the major causes of blindness, ocular morbidity and disability among those aged ≥40 years.

Sampling Design:

Multi-stage stratified cluster random sampling, with population proportionate to size (PPS) procedures were used to identify a representative sample. The primary sampling unit for the survey was the district and clusters were identified in all 25 districts in Sri Lanka. The number of clusters in each district was dependent on the size of the population residing in each district. Thus more populated districts had more clusters compared to less populated districts. However the survey was powered for national level estimates and therefore will not provide accurate estimates at district level. Separate sampling frames

were drawn up for urban and rural areas in each district. For urban clusters, all urban areas were pooled together in the sampling frame. Rural and urban areas were defined using definitions adopted by the National Census in Sri Lanka.

A total of 100 participants aged ≥40 years were enumerated in each cluster. In small rural clusters where there were fewer than 100 adults of this age, enumeration continued in the nearest village until 100 participants were recruited. Since 6600 individuals were recruited, a total of 66 clusters were identified across the country. As it was desirable to include all 25 districts, two further clusters were included, one each in Mannar and in Mullaitivu districts (total 68 clusters)(Appendix 1)(Table 4). The exact location for each cluster was randomly identified based on the village/ cluster population, using 2012 census data.

Definitions Used in the study

Household: A household was defined as all those living under the same roof and eating from a common kitchen routinely. If the head of the household had more than one wife and the wife and children lived in a different compound, they were treated as a separate household.

Normal resident: Individuals who had lived in the cluster continuously for three months prior to the survey were categorized as a normal resident.

Eligible respondent: All individuals aged ≥40 years and residing continuously in the cluster for the preceding three months were eligible for inclusion for the eye examination.

Urban cluster: All areas administered by Municipal or urban councils were defined as being urban.

Rural cluster: All other areas which were not administered by municipal or urban councils were defined as rural.

Socio-economic status: A questionnaire was administered to collect information on the possession of different movable assets (television, computer, radio, cycle, motor cycle, car, refrigerator, air conditioner etc.). A scoring system was devised based on the monetary value of each asset. Scores assigned to each asset were then cumulated to compute a family asset score. The family asset scores of the survey population was then categorized into four groups by calculating quartiles based on the family asset score. Families and individuals in the families were then categorised as follows:

Upper socio economic status: Top quartile of the family asset distribution
Upper middle socio-economic status: 2nd quartile of the family asset distribution
Lower middle socio-economic status: 3rd quartile of the family asset score
Lower socio-economic status: Lowest quartile of the family asset score

Blindness:

The following categories were used in the survey to define blindness and visual impairment. Blindness and severe visual impairment are defined according to WHO categories while other vision categories defined were modified from the WHO definitions [21].

Blindness: presenting VA (with glasses for distance if normally worn or unaided if glasses for distance not worn) of <20/400 (<3/60) in the better eye.

Severe visual impairment (SVI): presenting VA <20/200-20/400 (<6/60-3/60) in the better eye. *Moderate visual impairment* (ModVI): presenting VA <20/63-20/200 (< 6/18-6/60) in the better eye. *Mild visual impairment* (Mild VI): presenting VA <20/40 to 20/63 (< 6/12 –6/18) in the better eye.

Normal/Near normal: presenting vision ≥ 20/40 (≥ 6/12) in the better eye.

Cataract Surgical Coverage (CSC)

This measure indicates the extent to which people who are cataract blind have accessed services. Cataract surgical coverage can be calculated at the person and at the eye level. Calculation of CSC at the person level was performed for three visual impairment cut-offs: <3/60, <6/60 and <6/18 using the formula:

$(x + y)/(x + y + z) * 100$ where:

x = persons with unilateral pseudo/aphakia and visual impairment in contralateral eye

y = persons with bilateral pseudo/aphakia, regardless of acuity.

z = persons with <3/60, <6/60 and <6/18 in whom the principle cause was cataract (unilateral or bilateral)

Ethical approval

The study protocol was reviewed by Institutional Ethics Committees of London School of Hygiene & Tropical Medicine, London, UK, Ethics Committee of Faculty of Medicine, University of Colombo, Sri Lanka and the Indian Institute of Public Health, Hyderabad. All the bodies approved the protocol which was used in the study.

A Project Steering Committee (PSC) was formed to guide the survey. Members of the PSC included Vision2020 officials, representatives of the College of Ophthalmologists, International NGOs and representatives from the International Centre for Eye Health, Department of Clinical Research, London School of Hygiene & Tropical Medicine, UK. The PSC met periodically to review progress and solve outstanding problems. The Sightsavers Sri Lanka Country Office provided all the logistic and administrative support for the survey.

Training and pilot studies

Two study teams were constituted for the survey. Both teams worked concurrently. Each team composed of 1 ophthalmologist, 2 optometrists, 1 team coordinator, 4 interviewers, 1 field supervisor and two drivers cum helpers. All survey team members underwent specialised training for one week at the start of the survey. The training was led by technical experts from ICEH. A detailed survey protocol manual outlining the survey activities, a guide for completing the questionnaire interview and information about the duties and responsibilities of all survey personnel was given to each team member. Training also dwelt upon the algorithms for diagnosis and for identification of the principal cause of visual impairment. The team approach was emphasised during the training and clear job responsibilities were communicated to all personnel. Training was followed by a pilot in two clusters before the main study started. Data from the pilot studies were analyzed immediately and feedback provided to all the members on each occasion.

A crucial input in the training and pilots was studies on inter-observer agreement. Inter-observer agreements were undertaken for the ophthalmologists and the optometrists. Wherever agreement was below expectations, personnel were replaced if retraining did not improve the agreement.

Enumeration

Proper enumeration is of crucial importance in a cross sectional, prevalence survey, providing the correct denominator for determining blindness and low vision rates.

Mapping and Identification of cluster segment for survey:

In urban clusters identification of the specific street blocks for enumeration was based on comprehensive municipal maps from the Cartography Department of the Department of Census and Statistics, Government of Sri Lanka. In the urban areas selected via the PPS sampling strategy, each street block was assigned a number, one of which was then randomly chosen for enumeration purposes.

The Project Manager and Team Coordinator visited survey villages/street blocks in advance where they met Public Health Midwife and Grama Niladhari (village leader) to explain the purpose of and procedures for the survey, to obtain consent for undertaking the survey and to request full participation of all eligible persons. Typically 2-3 days were required to enumerate each cluster.

The enumerators first determined the central point of the village. Next, they randomly chose a direction (e.g. by spinning a plastic bottle while standing at the centre point) in order to determine the direction to walk away from the centre point so as to carry out the enumeration. Proceeding systematically from the identified reference point, identifying participants involved a two-person enumeration team serially assigning a number to each household and registering the names, ages and sex of all habitual occupants until 100 eligible people ≥40 years were listed for each given cluster. Every household was assigned a survey household number irrespective of whether there was a 40 year old person or not in that household. If a house was locked at the first visit, neighbours were informed that the team would return later in the day. Repeat visits were made on the same day to gather information about the locked house. If contact was not established after two visits the household was categorised as a non-responding household.

Enumerators explaining the survey

Procedures at the examination site

An examination site was set up in each cluster with space for interviews, measuring height and weight and for clinical investigations. (See Figure 2 for a flow chart of procedures.)

The field supervisor systematically identified one out of every ten adults aged ≥40 years as they reported to the examination site for a detailed eye examination regardless of the findings. This was to collect normative data. The purpose of the normative dataset was to determine the distribution of ocular variables (such as intraocular pressure) in the normal population.

Written informed consent was obtained from each participant by the enumerators and interviewer. Personal and demographic data were recorded prior to the eye examination by a trained interviewer. All participants had their blood pressure (3 readings), height and weight measured. All participants underwent distance visual acuity measurement with an ETDRS logarithm of minimum angle of acuity (logMAR) tumbling "E" chart. Presenting visual acuities were measured in each eye separately at 4 metres, and at 1 meter if necessary. Participants who could not see any letter at 1 meter were assessed by the ophthalmologist, for finger counting, hand movements and light perception (PL/NPL) in a darkened room. Participants who did not understand the test or who had communication difficulties were assessed and their vision was labelled as 'not' Recorded.

Measuring visual acuity at the examination site

Survey participant having their visual acuity measured at the examination site

All participants then underwent ophthalmic examination by the ophthalmologist. All participants also underwent automated refraction and biometry. Participants with moderate visual impairment or worse were dilated and were examined in more detail, which included retesting visual acuity with the auto-refraction results placed in a lens trial frame. They also had a slit lamp examination with dilated fundus examination. Participants also had visual field and fundus photos as per protocol.

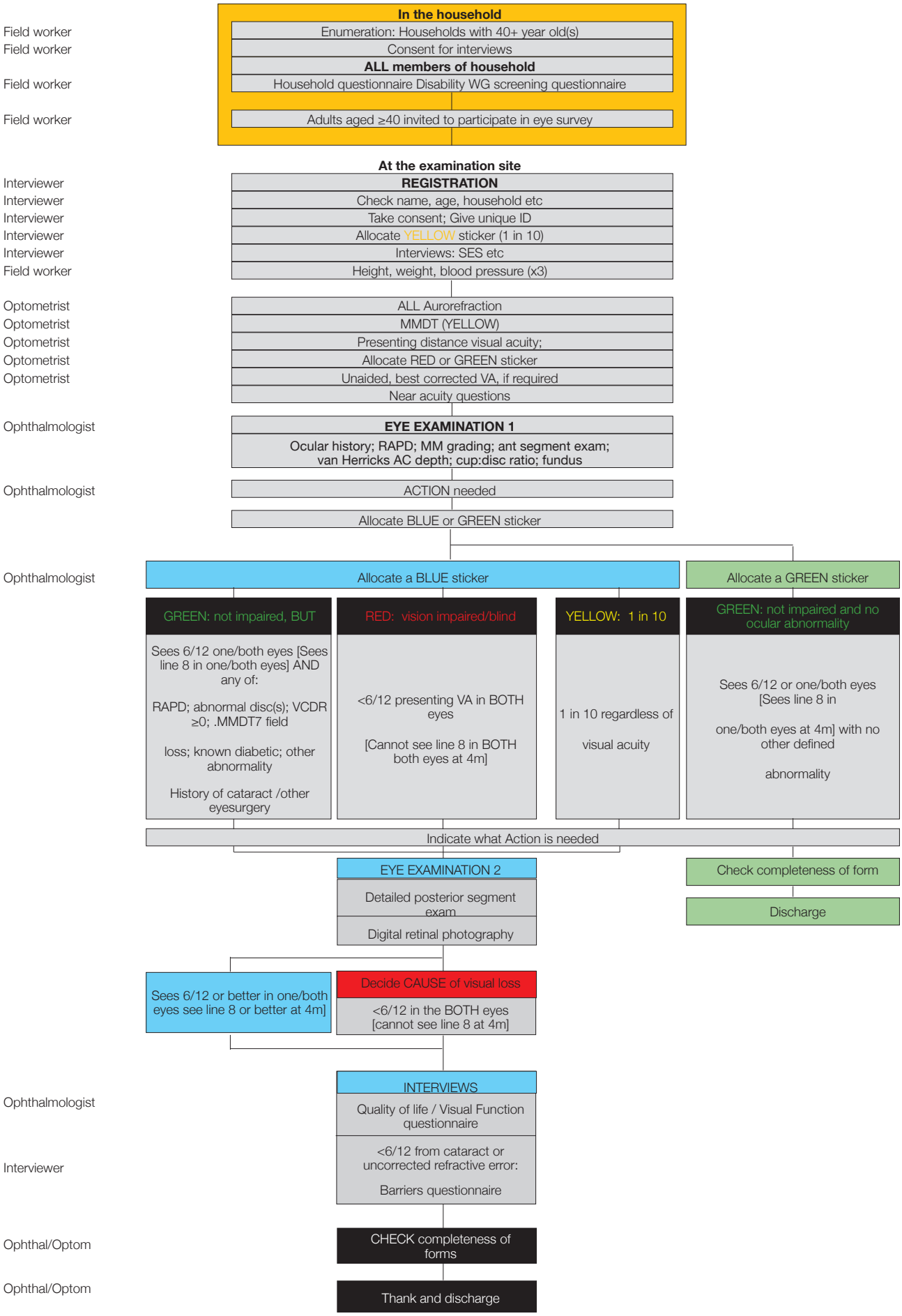
Examination by a survey ophthalmologist

Auto refraction to assess refractive errors

Visual functioning questionnaires and barriers to access questionnaire were also administered to the following:

- Those with presenting vision <6/60 in the better eye where cataract was the cause of visual loss.
- Those with presenting vision <6/60 in the better eye where uncorrected refractive error was the cause of visual loss.
- All those who had undergone cataract surgery in one or both eyes, irrespective of their visual outcome (only visual functioning questionnaire).

Figure 2 Flowchart of examination protocol



Data management and analysis

A record sheet was completed for each eligible enumerated participant, which was cross-checked for errors by the ophthalmologists in the field and the project coordinator in the office. The data were subsequently entered into a customized database (with built in range and consistency checks) by an experienced data officer and independently crosschecked by a second data officer. Data cleaning and analysis was done using STATA 13.0 (Stata Corp LP, Texas, USA) by a dedicated statistician at the Indian Institute of Public Health, Hyderabad.

Descriptive analyses and cross tabulations with calculation of Pearson chi squared tests were performed. Further analyses were undertaken to explore risk factors for participants using logistic regression with generalised estimating equations to adjust for dependency in the data due to clustered sampling. All tests are two sided, and the odds ratios (OR) and 95% confidence intervals (CI) quoted are derived from logistic regression models. To account for differential non-response, the blindness prevalence estimate was standardized by age and gender, using the most recent population estimates.

Service component

All participants with visual impairment were referred to the nearest eye facility. People with operable cataract were referred to the cataract service centers where free cataract surgery had been organized for survey participants. Participants with mild ocular or systemic complaints were also treated as were other non-survey participants who attended the examination sites with ocular complaints. Reading glasses were prescribed and provided free of charge for those who were in need.

b. RESULTS AND DISCUSSION

Demographic characteristics

A total of 3,392 households were enumerated, where 12,631 individuals of all ages resided. The average household size was 3.72 individuals.

There was a predominance of females (52.8%) in the study population (Table 4). This is in line with the Sri Lanka national census data where the proportion of females in the national population is 51.6%. Overall sex ratio in Sri Lanka is 996 males for 1000 females. Except the overall age group proportions where there was some difference, all other demographic characteristics were similar to the national census 2012.

Table 4: Demographic characteristics of study population

	Parameter	No.	%
	Households enumerated	3392	
	Individuals enumerated	12631	
Gender	Female	6667	52.8
	Male	5964	47.2
Age Groups	≤11 years	1387	11.0
	12 –18 years	1381	10.9
	19 –39 years	3150	24.9
	40 –49 years	2053	16.2
	50 –59 years	2178	17.2
	60 –69 years	1570	12.4
	≥70 yrs	912	7.2
Place of residence	Rural	11,107	87.9
	Urban	1524	12.1
Religion	Buddhist	9517	75.4
	Hindu	1719	13.6
	Christian	903	7.1
	Islam	492	3.9
Ethnic Group	Sinhala	9969	78.9
	Tamils	2206	17.5
	Moors	456	3.6
Province	Western	3719	29.4
	Southern	1487	11.8
	Central	1369	10.8
	North Western	1291	10.2
	Northern	1191	9.4
	Sabaragamuwa	1088	8.6
	Eastern	911	7.2
	North Central	793	6.3
	Uva	782	6.2

Response rate

A total of 5779 individuals attended for examination out of 6713 giving a high overall response rate of 86.1% (Table 5). The mean age of those examined was similar to those enumerated. There was a significant difference in response rates between males and females (X^2-228.11; $p < 0.001$). This suggests selection bias as the more productive male population would be away at work and are likely to have better vision compared with unemployed older women who may have a higher risk of being visually impaired or blind.

Table 5: Demographic Characteristics of population aged 40 years or above

Parameter	Enumerated		Examined		Response Rate
	N	%	N	%	%
Total aged ≥40 years	6713		5779		86.1
Age groups					
40 -49 y	2053	44.53	1708	29.6	83.2
50 –59 y	2178	54.17	1859	32.2	85.4
50 –69 y	1570	63.63	1424	24.6	90.7
70+ y	912	76.16	788	13.6	86.4
Mean age					
Men and women	56.42±11.02		56.67±10.9		
Male	56.50±10.76		57.26±10.74		
Female	56.36±11.23		56.26 ±10.99		
Gender					
Male	2984	44.4	2356	40.8	78.9
Female	3729	55.6	3423	59.2	91.8
Education					
Illiterate	359		334		93.0
Primary Level	1576		1317		83.6
Secondary Level	4652		4026		86.5
Graduate & above	126		102		80.9
Residence					
Rural	5904		5102		86.4
Urban	809		677		83.7
Province					
Western Province	1926		1648		85.6
Central	800		695		86.9
North Western	678		586		86.4
Eastern Province	490		415		84.7
Northern Province	644		553		85.9
Sabaragamuwa	601		510		84.8
North Central	406		346		85.2
Uva Province	396		348		87.9
Southern Province	792		678		85.6

Visual acuity findings

Vision could not be recorded in 14 (0.2%) individuals who attended for examination (Table 6). This was because they were either intellectually impaired, completely bed-ridden or were drunk at the time of the examination. Using presenting visual acuity, 13.6% had mild VI; 15.4% had moderate VI; 1.6% had SVI and 1.7% were blind. 81% of participants with severe visual impairment (SVI) improved with best correction while 78.1% of blind participants could not be improved by refraction and correction.

Table 6: Matrix of presenting and best corrected vision categories (person level)

Presenting Vision	Best Corrected Vision						
	≥6/1	<6/12-6/18	<6/18-6/60	<6/60-3/60	<3/60	Total	
≥6/12	3899 100.0%	0	0	0	0	3899	**67.5%**
<6/12-6/18	686 87.1%	102 12.9%	0	0	0	788	**13.6%**
<6/18-6/60	493 55.3%	184 20.6%	215 24.1%	0	0	892	**15.4%**
<6/60-3/60	10 11.1%	14 15.6%	49 54.4%	17 18.9%	0	90	**1.6%**
<3/60	1 1.0%	5 5.2%	11 11.5%	4 4.2%	75 78.1%	96	**1.7%**
VA not recorded						14 (0.2%)	**0.2%**
Total	**5089**	**305**	**275**	**21**	**75**	**5779**	**100**

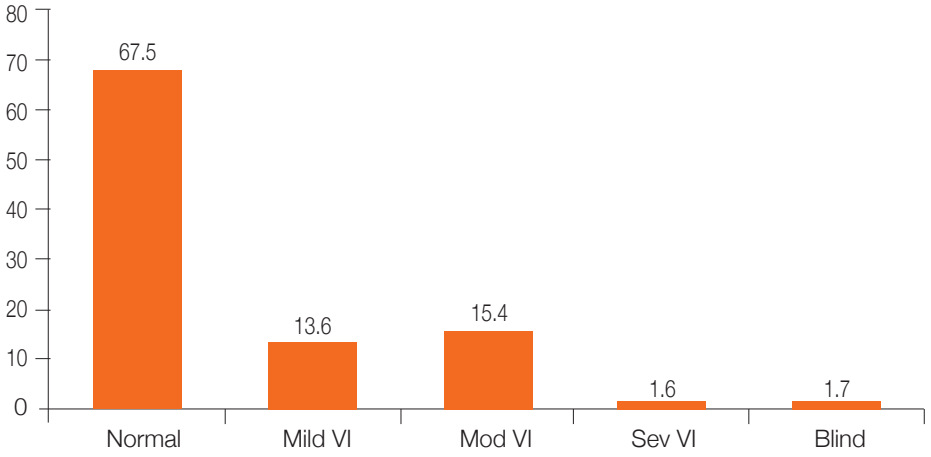
Prevalence of Blindness and Visual Impairment

The WHO classification based on presenting vision was used to compute the prevalence of different categories of blindness and visual impairment. The prevalence of blindness in Sri Lanka was 1.7% (95% CI: 1.3 –1.99) among those aged 40+ years. This is significantly lower than the prevalence of blindness reported from surveys of ≥40 year populations in other countries of South Asia in the past two decades (India, Myanmar)[11,13,15]. Only one study from Nepal has reported a lower prevalence [17]. The only other study from Sri Lanka is from the Kandy region in Central Province in Sri Lanka. This study reported the prevalence based of best corrected vision among those aged 40 years or older [19]. The prevalence from Kandy was reported to be 1.1% compared to 1.3% in the present study.

Table 7: Prevalence of blindness and visual impairment (presenting vision in the better)

Vision Category	No.	Prevalence	95% CI
Normal /near) normal (	3899	67.5%	66.3– 68.7%
Mild visual impairment (<6/12-6/18)	788	13.6%	12.7– 14.5%
Moderate visual impairment (<6/18-6/60)	892	15.4%	14.5– 16.4%
Severe visual Impairment (<6/60)	90	1.6%	1.2– 1.9%
Blind (<3/60)	96	1.7%	1.3– 1.99%
Vision Not recorded	14	0.2%	0.12– 0.37%

Figure 3: Distribution of vision categories



Univariate analysis showed that blindness was significantly associated with increasing age, lower socio-economic status, Hindu religion, Tamil ethnic group and lower literacy (Table 8). After adjusting for the different socio-demographic factors, increasing age and poor literacy status were remained significantly associated with high levels of blindness (Table 9).

Table 8: Association of blindness with socio demographic characteristics

	Socio-demographic variables	Examined	Blind	Prevalence	Chi²
		N	N	%	
Age group	40 -49 years	1708	3	0.2	
	50 –59 years	1859	8	0.43	
	60 –69 years	1424	19	1.33	
	≥ 70 years	788	66	8.4	258.72; p <0.001
Gender	Male	2356	35	1.5	
	Female	3423	61	1.8	0.75; p=0.34
Province	Uva	348	10	2.87	
	Eastern	415	11	2.65	
	North West	586	15	2.56	
	North	553	12	2.17	
	Central	695	13	1.87	
	North Central	346	6	1.73	
	Sabaragamuwa	510	7	1.37	
	Western Province	1648	20	1.21	
	South	678	2	0.29	19.61; p=0.01
Socio economic status	Lowest quartile	1599	47	2.94	
	Lower middle quartile	1663	20	1.2	
	Upper middle quartile	1288	17	1.32	
	Highest quartile	1229	12	0.98	22.58; p<0.001
Residence	Rural	5102	88	1.72	
	Urban	677	8	1.18	1.07; p=0.29

	Socio-demographic variables	Examined	Blind	Prevalence	Chi²
		N	N	%	
Religion	Hindu	839	24	2.86	
	Buddhist	4359	64	1.47	
	Christian	389	7	1.80	
	Islam	192	1	0.52	9.95; p=0.02
Ethnic group	Tamil	1053	27	2.56	
	Sinhala	4546	68	1.5	
	Moor	180	1	0.56	7.36; p=0.02
Literacy	Not literate/ < Primary	327	28	8.56	
	Schooling to O level	1332	38	2.85	
	O level or above	4120	30	0.73	128.8; p<0.001

Table 9: Association of blindness and socio demographic variables (multivariate analysis)

Socio-demographic variables	Adjusted OR	95% CI
Age Group		
40 -49 years (1708)	1.0	
50 –59 years (1859)	4.00	0.66 –24.42
60 –69 years (1424)	7.33	1.79 – 30.01
≥ 70 years (788)	219.5	7.18 – 670.9
Gender		
Female (3355)	1.0	
Male (2356)	1.04	0.67–1.63
Socio Economic Status		
Lowest quartile(1599)	1.0	
Lower middle quartile (1663)	0.56	0.32 –1.00
Upper middle quartile(1288)	0.71	0.38 –1.34
Highest quartile (1229)	0.65	0.32 –1.31
Ethnic group		
Tamils(1050)	1.0	
Sinhala (4549)	0.57	0.34 – 0.96
Moors (180)	0.00	-
Literacy		
Completed O level or more	1.00	
Completed primary schooling but not O level	1.46	0.84 – 2.55
Illiterate/ Less than primary	3.01	1.47 – 6.14

Causes of blindness and visual impairment

Uncorrected refractive errors were the commonest cause of mild, moderate and severe visual impairment followed by lens related causes (Table 10). Cataract was the commonest cause of blindness followed by uncorrected refractive errors. All previous studies in the South Asia region have also shown that cataract is the predominant cause of blindness [9-18]. The proportion of blindness due to cataract has ranged from 50-85% in these studies. The only other study from Sri Lanka showed that cataract (79%) followed by ARMD (15%) were the commonest causes [19]. Uncorrected refractive errors did not feature as a cause of blindness in this study as blindness was defined on the basis of best corrected vision.

Table 10: Causes of blindness and visual impairment (presenting vision in better eye)

Causes	Mild VI		Moderate VI		Severe VI		Blind	
	n-788		n-892		n-90		n-96	
	N	%	N	%	N	%	N	%
Refractive errors	638	81.0	571	64.0	42	46.7	12	1 2.5
Lens related								
Cataract	62	7.9	205	22.9	33	36.7	64	6 6.7
Pseudoaphakia	60	7.6	71	8.0	2	2.2	2	2.1
PCO	8	1.0	14	1.6	5	5.6	2	2.1
Surgical complications	1	0.1	2	0.2	1	1.1	2	2.1
Uncorrected aphakia	8	1.0	7	0.8	2	2.2	0	0
Glaucoma	0	0.0	1	0.1	0	0.0	2	2.1
Retinal disorders								
Diabetic retinopathy	3	0.4	3	0.3	0	0.0	0	0.0
Other vasculopathy	0	0.0	1	0.1	0	0.0	0	0.0
ARMD	2	0.3	2	0.2	2	2.2	2	2.1
Other retinal disorder	1	0.1	6	0.7	0	0	5	5.2
Other disorders								
Corneal opacity	0	0.0	2	0.2	0	0.0	0	0
Optic atrophy	0	0.0	0	0.0	0	0.0	1	1.0
Amblyopia	5	0.6	7	0.9	3	3.3	1	1.0
Phthisis	0	0.0	0	0.0	0	0.0	1	1.0
Cause could not be determined							2	2.1
		100		100		100		100

VI = visual impairment; PCO = Posterior capsule opacification; ARMD = age related macular degeneration

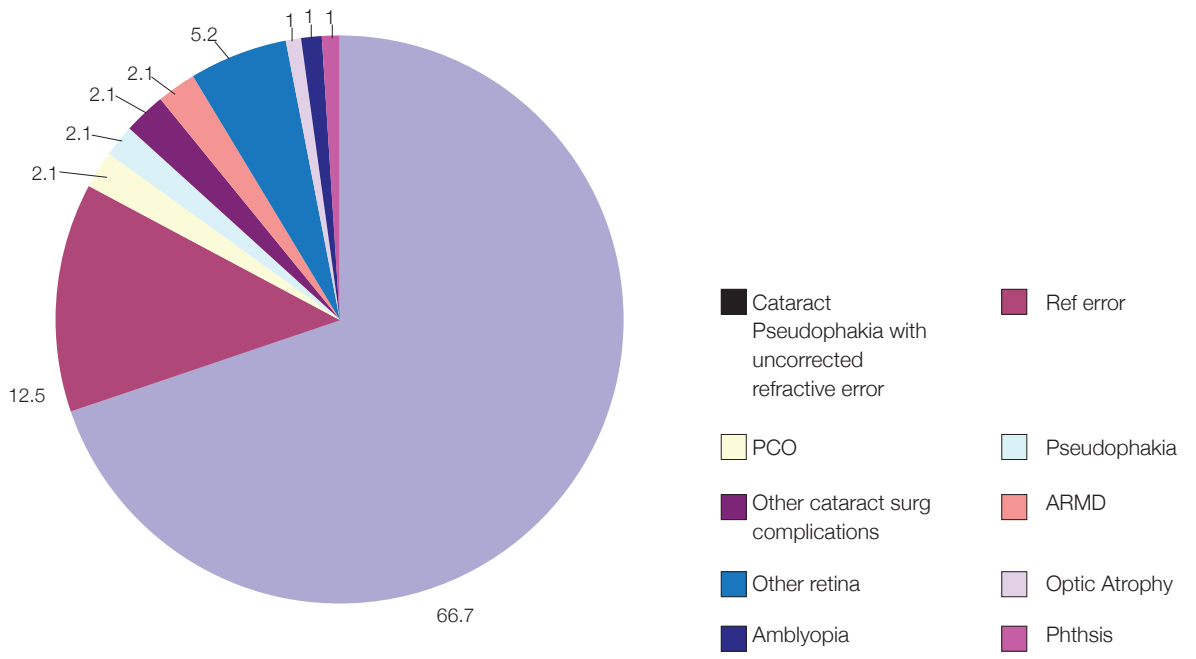


Figure 4: Causes of blindness among adults aged 40 years and above in Sri Lanka (%)

Visual outcomes after cataract surgery

86.0% (345) participants reported having undergone cataract surgery in one or both eyes (Table 11). Among the 486 cataract operated eyes, 93.8% underwent IOL surgery. The majority had undergone cataract surgery in Government facilities (72.8%).

The WHO categorizes visual outcome after cataract surgery as 'good (presenting/best vision <6/18), 'borderline' (presenting/best vision <6/18 to 6/60), and 'poor' (presenting/best vision <6/60). WHO further states that 85% (presenting vision) or 90% (best corrected vision) should have a good outcome, 15% (presenting vision) or 5% (best corrected vision) borderline outcomes and ≤5% (presenting or best corrected vision) poor outcomes as acceptable parameters of success [24]. In this survey, 75.1% (best corrected) / 59.7% (presenting) had a good outcome, while 16.1% (best corrected) / 28.2% (presenting) had borderline outcome and 8.8% (best corrected) / 12.1% (presenting) had a poor outcome. Therefore WHO standards of visual outcome were not met but are comparable to recent surveys in India [25,26], Singapore [27,28], Brazil [29] and Bangladesh [30].

Table 11: Cataract Surgery particulars

Parameter		N	%
Persons operated for cataract		345	6.0
Eyes operated for cataract		486	
Intraocular lens surgery (eyes)		456	93.8
Place of surgery (eyes)	Government hospital	354	72.8
Duration since surgery (eyes)	Less than five years (2010-)	261	53.7
	Prior 5 –10 years (2004-2009)	111	22.8
	More than 10 years ago (< 2004)	89	18.3
	Year not known	25	5.1
Presenting visual acuity (eyes)	Good visual outcome (6/18 or better)	290	59.7
	≥6/12	198	40.7

Parameter		N	%
	<6/12-6/18	92	18.9
	Borderline visual outcome (< 6/18-6/60)	137	28.2
	Poor visual outcome (< 6/60)	59	12.1
	<6/60 –3/60	13	2.7
	<3/60	46	9.5
Best corrected visual acuity	Good visual outcome (/18 or better)	365	75.1
(eyes)	≥6/12	284	58.4
	<6/12-6/18	81	16.7
	Borderline visual outcome (< 6/18-6/60)	78	16.1
	Poor visual outcome (< 6/60)	43	8.8
	<6/60 –3/60	45	1.0
	<3/60	38	7.8

Cataract Surgical Coverage

Cataract surgical coverage (CSC) is used as indicator of the extent to which the need for cataract surgery has been met in the population. It is helpful in identifying areas and subgroups in the population that need priority attention.

Cataract surgical coverage can be computed at individual eye level as well as at the person level. Person level data are more relevant in identifying targets to meet the goals of Vision2020. CSC can be calculated at three different visual acuity cut-off levels: 3/60; <6/60 or < 6/18. A high CSC at <3/60 level is the first goal for Vision2020 such that all population sub-groups and regions which have a lower coverage can be targeted for urgent attention. A high CSC indicates that a significant proportion of those in need of cataract surgical services have accessed surgery while a low CSC means the needs of the population are not being met.

In Sri Lanka the CSC was 85.4% at the 3/60 cut off level in Sri Lanka (Table 12). This means that 85% of bilaterally cataract-blind individuals have undergone surgery. This is significantly higher than most other countries in Asia (Bangladesh, China, Mynamar, Nepal) [30-33] and Africa (Rwanda, Eritrea, Malawi, Nigeria, Tanzania) [34-40]. Similar CSC as in Sri Lanka have been seen in Kenya [38], India [25,42], Pakistan [41], Cameroon [42] and Brazil [29].

Table 12: Cataract surgical coverage (person level; presenting vision in better eye)

Visual acuity cut off	Cataract Blind	Cataract operated in one or both eyes	Cataract blindness load	Cataract Surgical Coverage (%)
VA < 3/60	59	345	404	85.4
VA < 6-60	91	345	436	79.1
VA < 6/18	289	345	634	54.4

Analysis of CSC in Sri Lanka showed that CSC was significantly lower at older ages, among those with poorer literacy, lower economic status and those residing in North West, Uva and Central provinces in Sri Lanka (Table 13). Differences by sex, religion, place of residence and ethnicity were not statistically significant.

Table 13: Association of Cataract Surgical Coverage (< 3/60 in the better eye-person level) with socio-demographic characteristics

Parameters	Description	Cataract Surgical Coverage (%)	X^2
Age Category	40 –49 years	100.0	
	50 –59 years	95.3	
	60 –69 years	88.5	
	≥ 70 years	80.6	X^2-10.61; p=0.01
Sex	Female	84.8	
	Male	85.7	X^2-0.06; p=0.80
Education	Not literate/ less than primary	66.7	
	Completed primary but not O level	83.3	
	Beyond O level	92.1	X^2-25.88; p < 0.001
Place of residence	Rural	83.3	
	Urban	94.47	X^2-6.35; p=0.01
Socio economic status	Lowest quartile	73.8	
	Lower middle quartile	90.1	
	Upper middle quartile	88.6	
	Upper quartile	94.0	X^2-21.56; p < 0.001
Ethnic Group	Tamils	86.5	
	Sinhala	81.1	
	Moors	91.7	X^2- 2.12; p=0.3
Religion	Hindu	78.9	
	Christian	83.3	
	Buddhist	87.1	
	Islam	91.7	X^2-3.65; p=0.3
Province	North West	55.6	
	Uva	60.0	
	Central	71.4	
	Eastern	81.2	
	Sabaragamuwa	85.7	
	Northern	486.0	
	North Central	88.9	
	Western	91.9	
	Southern	100.0	X^2-45.32; p <0.001

Visual functioning

Visual functioning was assessed among those blind due to cataract and uncorrected refractive errors and those previously operated for cataract. Seven domains were assessed: activity limitation, difficulty with distance and near tasks, peripheral vision, contrast sensitivity, colour vision and depth perception (Table 14). Except in near vision tasks and some aspects of contrast vision where there were no statistically significant differences between the three groups, statistically significant differences were observed in all the other domains. Cataract blind persons had the worst visual functioning while those who had undergone cataract surgery had far better outcomes in ~~all~~ most domains. Depth perception was a problem among the cataract operated compared to those severely visually impaired or blind from uncorrected refractive errors. The intention was to assess vision functioning in individuals in the "normative data set" but very few individuals with normal vision responded to the questionnaire.

Table 14: Visual functioning among cataract blind persons (<6/60 better eye) or cataract operated (any eye) or uncorrected refractive error (<6/60 better eye)

Parameter	Cataract Blind	Uncorrected refractive error blind	Cataract operated either eye
Reported	N=97	N=54	N=345
	Lot of Difficulty	Lot of Difficulty	Lot of Difficulty
Activity limitation			
Daily activities limited by sight	49.5% (48)	20.4% (11)	19.1% (66)
	X^2-37.8; p < 0.001		
Distance tasks			
Problem recognizing people across the street	66.0% (64)	61.1% (33)	38.0% (131)
	X^2-29.5; p < 0.001		
Problem recognizing face of person standing near	35.0% (34)	11.1% (6)	13.6% (47)
	X^2-25.8; p < 0.001		
Problem locating something when surrounded by other things	37.1% (36)	3.7% (2)	14.8% (51)
	X^2-34.0; p < 0.001		
Near Tasks			
Problem recognizing small or minute objects	69.1% (67)	63.0% (34)	66.4% (229)
	X^2-0.59; p=0.7		
Peripheral vision			
Problem noticing objects at the side	52.6% (51)	31.5% (17)	23.2% (80)
	X^2-31.3; p < 0.001		
Contrast			
Problem adjusting to darkness after being in bright light	64.9% (63)	55.5% (30)	51.9% (179)
	X^2-5.23; p =0.07		

Parameter	Cataract Blind	Uncorrected refractive error blind	Cataract operated either eye
Reported	N=97	N=54	N=345
	Lot of Difficulty	Lot of Difficulty	Lot of Difficulty
Problem adjusting to bright light after being in darkness	49.5% (48)	42.6% (23)	37.4% (129)
	X^2-44.73; p=0.409		
Problem recognizing a person when in bright light	59.8% (58)	48.1% (26)	36.5% (126)
	X^2-17.6; p < 0.001		
Problem seeing with bright lights on the eyes	66.0% (64)	66.7% (36)	42.9% (148)
	X^2-22.9; p < 0.001		
Colour vision			
Problem recognizing colours	23.7% (23)	3.7% (2)	6.9% (24)
	X^2-26.5; p < 0.001		
Depth perception			
Problem in reaching for an object (depth perception)	28.9% (28)	9.2% (5)	12.7% (44)
	X^2- 16.8; p < 0.001		

Barriers to service access

Barriers to accessing eye care services were elicited from severely visually impaired and blind individuals with cataract and uncorrected refractive errors (Table 15). Expenses related to treatment followed by family responsibilities/obligations were the commonest reasons cited. Perceived barriers were more common among the cataract blind/severely visually impaired compared to those impaired due to uncorrected refractive errors.

Table 15: Commonest Barriers reported to accessing services amongst cataract or refractive error blind & SVI (< 6/60 better eye)

Barrier	Cataract (n-97)		Refractive error (n-54)	
	N	%	N	%
Too expensive	59	60.8	35	64.8
Other family priorities	32	33.0	12	22.2
No one to accompany	16	16.5	6	11.1
Can manage - no need	11	11.3	15	27.8
No time	8	8.2	8	14.8
Fear / apprehension	5	5.1	1	1.8
Did not know where to go	4	4.1	1	1.8
Did not know treatment possible	3	3.1	4	7.4
Others	8	8.2	4	7.4

Ocular morbidity and health seeking behaviour

The reported ocular morbidity, treatment preferences and cost of eye treatment were also assessed among the 40+ population (Table 16). 90% of the participants reported that they had experienced an eye problem in the preceding month. Diminished vision either for near or distance was the commonest complaint reported. Less than a third (31.4%) sought treatment for the eye problem. Among the 3516 participants who stated that they had not sought any treatment, reasons for not accessing treatment were also assessed. Lack of seriousness regarding the eye problem and lack of finances were the commonest barriers highlighted by these participants (Table 16).

Table 16: Health seeking behaviour for eye problems among 40+ population

Parameter	No. (5779)	%
Reported an eye problem in the preceding month	5193	90.0%
Main eye problem reported in preceding month		
Diminished near vision	3617	69.6
Diminished distance vision	1709	32.9
Irritable, sore, burning eyes	758	14.6
Watering without discharge/redness/pain	592	11.4
Foreign body in eye	84	1.62
Pain in the eye	58	1.1
Red eye with discharge	50	0.96
Dry eye	19	0.37
Reported seeking treatment for eye problem	1631	31.4
Reasons reported for not seeking treatment	**3516**	**67.7**
Did not think it was serious enough to seek treatment	1415	40.2
Financial reasons	907	25.8
Lack of time	535	15.2
Used eye medicines that were available at home	235	6.7
Accept it as it is part of ageing	124	3.5
No one to accompany	97	2.6
Too far	83	2.4
Got better without any treatment	83	2.4
Did not know where to go	41	1.1
Expenditure on eye problems		
Mean expenditure for travel to access health care	254.31 Rs	1.91 US$
Mean expenditure on treatment of illness in preceding month	1310.1 Rs	9.82 US$
Mean total expenditure on illness in preceding month	1651.0 Rs	12.37 US$

General health

More than half the participants examined had normal nutritional status (Table 17), while 6% were obese. Only 13.8% said they knew that they were diabetic, 82%of whom were on medication. Only a quarter of the known diabetics acknowledged that they had undergone an eye examination. Nearly a fifth of the participants stated that they were hypertensive, 85.9% of whom were on medication. (Table 18)

The prevalence of diagnosed hypertension was 42.1% among those aged 40 years and older across Sri Lanka. An additional 38.7% were categorized as borderline hypertensive. 29.0% of individuals aged 30-49 were hypertensive.

The prevalence of hypertension and diabetes have been reported to be high in other studies in Sri Lanka [22,23].

Table 17: Nutritional status and rates and severity of hypertension

Parameter		N	%
BMI Categories (N=5660)	Underweight (<18.5)	917	16.2
	Normal (18.5-24.9)	3040	53.7
	Overweight (25.0-29.9)	1332	23.5
	Obese (≥ 30)	371	6.5
Diabetic status (N=5736)	Known diabetic (DM)	791	13.8%
	Known DM on treatment	652	82.4%
	Known DM previous eye exam.	207	26.2%
Hypertension			
Known to be hypertensive		1182	20.4%
Known hypertensive on anti-hypertensive medication		1016	85.9%
Mean systolic BP		134.21 (±19.3)	
Mean diastolic BP		84.9 (±11.7)	
Hypertension categories			
Normotensive (≤120/80mm Hg)		1101	19.2
Borderline-120 (≤140to-80mm≤89Hg)		2222	38.7
Hypertension - 140gradeto-901mm≤100(≤160Hg)		1548	27.0
Hypertension grade 2 (>160/>100 mm Hg)		869	15.1
Any degree of hypertension (>1		2417	42.1
Age groups with hypertension			
30-49 years (1703)		494	29.0%
50 - 69 years (3265)		1462	44.8%
70 years (772)		461	59.7%
Sex			
Males (2346)		1041	44.4%
Females (3394)		1376	40.5%

Smoking and exposure to sunlight are recognized to be important risk factors for lens opacities. The national survey found that more than one in five participants was either a current or a past smoker (Table 14). Two thirds of the participants were engaged in predominantly indoor activity, limiting their duration of exposure to sunlight.

Table 18: Life style and environmental risk factor status of examined individuals

Parameter		N	%
Smoking Status (N=5779)	Never smoked	4450	77.0%
	Past smoker	630	10.9%
	Current smoker	699	12.1%
Sun exposure group	Mainly indoor occupation/activity	3871	67.0%
(N=5,777)	Mainly outdoor occupation/activity	1906	33.0%

SURVEY OF DISABILITY

The Washington Group short questionnaire was used to identify persons with self-reported disability. The questionnaire was answered by an adult responsible member of the household, if other members of the household were not present. In case of children below the age of 12 years, the questionnaire detailing activity limitations was always filled by a proxy (responsible adult member of the household), while for those aged 12 years and more, the individual respondent was asked the questions. If the individual was not available then the responsible member of the same household answered on their behalf.

Disability was defined based on the Washington Group criteria [20]. The short set of 6 questions was used for this purpose. All stating that they experienced a lot of difficulty or could not perform the specific activity in one or more of the 6 domains were defined as persons with disability. This corresponds to moderate and severe levels of disability.

The overall prevalence of disability (moderate and more severity threshold ("a lot of problem to undertake the activity" or "inability to perform the activity")in one or more domains was 3.17% (95% CI: 2.87-3.50) (Table 19). This is higher than reported by the census estimates in Sri Lanka. The difference could be due to the definitions used as the present study used moderate and severe grades of disability whereas the census focused on severe grades of disability.

The prevalence of disability increased with age and those aged 70 years or more had nearly 21 times higher prevalence than children aged 0-17 years (Table 19). Females, those in the lowest socio-economic quartile and rural residents had significantly higher prevalence rates than other groups. Significant differences were also observed between different religious groups with those professing Islam reporting the lowest prevalence. There were no differences by ethnic group (Table 19).

Table 19: Prevalence of disability and association with socio-demographic variables

Parameter	No.	% [95% CI]	Chi sq test
	401	3.17 [2.87 –3.50]	
Age group			
0-17 years	19	0.74 [0.41-1.07]	
18-29 years	13	0.63 [0.29-0.97]	
30-49 years	67	2.01 [1.53-2.49]	
50 –69 years	163	4.35 [3.7-5.0]	
≥ 70 years	139	15.24 [12.91-17.57]	$X^2 = 556.75$; $P < 0.001$
Gender			
Male	152	2.55 [2.15-2.95]	
Female	249	3.73 [3.28-4.18]	$X^2 = 14.41$; $P< 0.001$
Socio Economic Status			
Lower SES (quartile 4)	145	4.45[3.74-5.16]	
Lower Middle SES (quartile 3)	132	3.82 [3.18-4.46]	
Upper Middle SES (quartile 2)	77	2.54 [1.98-3.1]	
Upper SES (Quartile 1)	47	1.63 [1.17-2.09]	$X^2 = 48.35$; $p< 0.001$
Place of residence			
Rural	308	2.77 [2.46-3.08]	

Parameter	No.	% [95% CI]	Chi sq test
Urban	93	6.10 [4.9-7.3]	X^2 = 48.32; p< = 0.001
Religion			
Christian	63	6.98 [5.32-8.64]	
Buddhist	291	3.06 [2.71-3.41]	
Hindu	39	2.27 [1.57-2.97]	
Islam	8	1.63 [0.51-2.75]	X^2 = 51.32; p< 0.001
Ethnicity			
Sinhalese	329	3.30 [2.95-3.65]	
Tamils	64	2.9 [2.2-3.6]	
Moors	8	1.75 [0.55-2.95]	X2 = 4.041; p= 0.133

WG criteria- Cannot do an activity or have a lot of problem doing the activity

Figure 5: Prevalence of disability at different age groups (% and 95% CI)

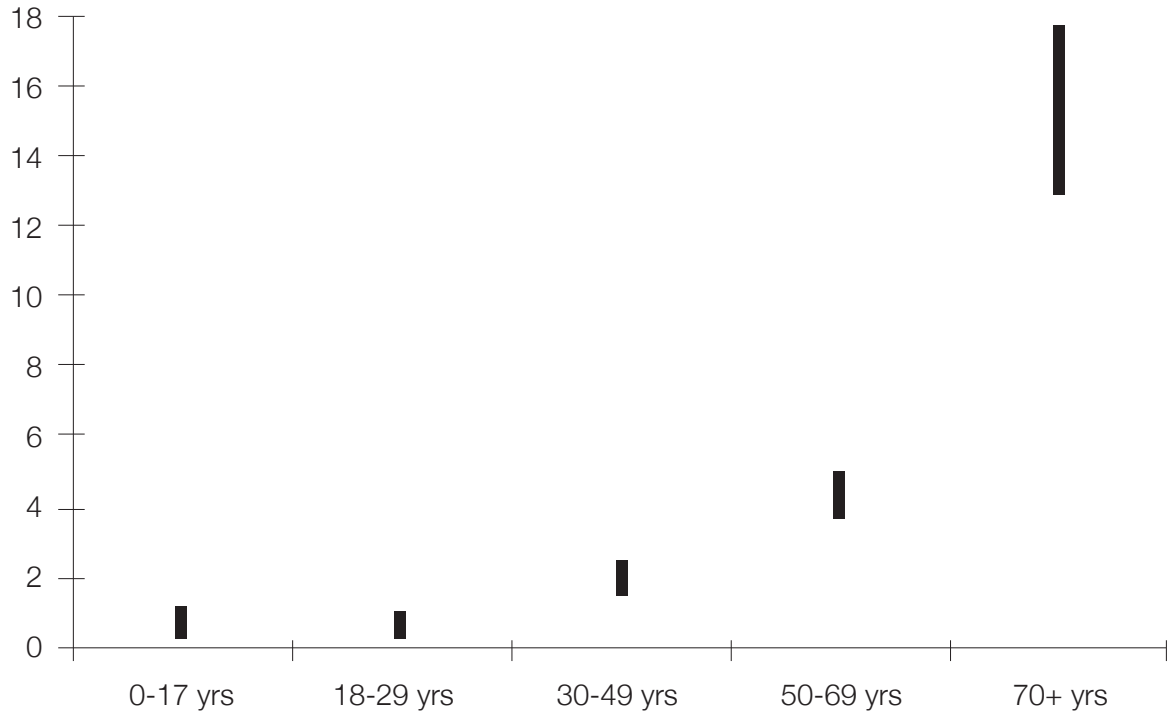
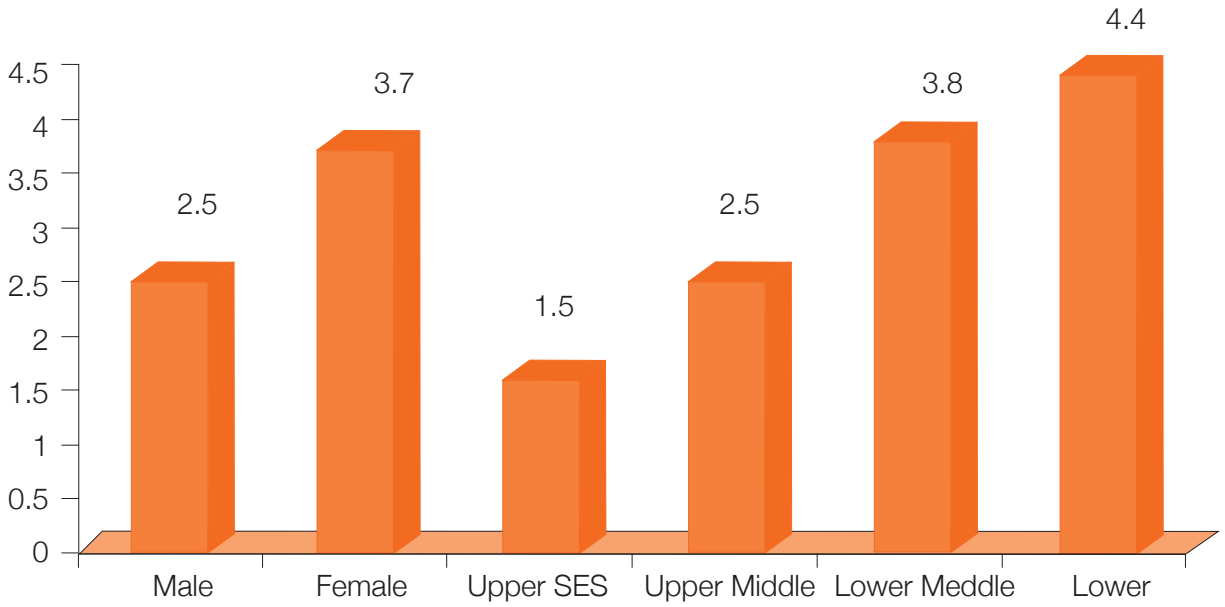


Figure 6: Prevalence of Disability by socio-demographic parameters (%)



Difficulties in mobility followed by difficulty in seeing were the commonest disabilities (Table 20). The proportion reporting difficulty in hearing, remembering or concentration, self-care and communication were much lower.

Table 20: Self- reported disabilities using Washington Group criteria by adults (aged 18 years and above)(n=10,064)

Parameter	No problems		Significant difficulty or unable to perform activity	
Difficulty walking or climbing stairs	9891	98.3%	173	1.72%
Difficulty seeing even with glasses	9,899	98.4%	165	1.64%
Difficulty hearing even with hearing aids	10,014	99.5%	50	0.5%
Difficulty remembering or concentrating	10,018	99.5%	46	0.5%
Difficulty with self-care	10,012	99.5%	52	0.52%
Difficulty in communicating	10,040	99.8%	24	0.24%
Difficulty in any of the above domains	9682	96.2%	382	3.8%

Females, people aged more than 30 years, those who were not literate and respondents from lower socio-economic status had significantly higher odds of reporting disability, compared to others. There were no significant differences due to ethnic group(Table 22).

Activity limitation

Activity limitation was assessed only for individuals aged 18 years or above. Problems taking part in community activities were the commonest issues highlighted (Table 21). Loss of dignity due to the behaviour of peers was of immense concern to persons with disabilities. This is stigmatizing and has a negative effect on the self-confidence and belief of persons with disabilities. Health issues were of concern to persons with disabilities as were the financial implications due to the health problem.

Table 21: Activity limitation and barriers to participation among adults aged 18+ years

Difficulty in performing an activity in the preceding 30 days (n=382)	Level of Difficulty			
	None	Some	A Lot	Cannot do
Problem in joining community activities	66.2% (253)	25.7% (98)	5.0% (19)	3.1% (12)
Problem living with dignity because of attitudes	82.7% (316)	16.2% (62)	1.0% (4)	0
Problems because of barriers or hindrance in the world around	86.9% (332)	11.8% (45)	1.3% (5)	0
Spending time on a health condition or its consequence	86.9% (332)	11.8% (45)	1.3% (5)	0
Emotionally affected by health condition	87.7% (335)	11.5% (44)	0.8% (3)	0
Health being a drain on financial resources of the family	82.5% (315)	14.9% (57)	2.6% (10)	0
How much of a problem did you have due to a health condition	85.1% (325)	13.9% (53)	1.0% (4)	0
Problems in doing things yourself for relaxation or pleasure	85.1% (325)	13.6% (52)	1.3% (5)	0

Table 22: Adjusted odds ratios for disability among adults aged 18+ years

Parameter		Adjusted OR	95%CI
Gender	Male	1.00	
	Female	1.34	1.07-1.68
Age group	18-29 years	1.00	
	30 –49 years	2.42	1.35 –4.32
	50 –69 years	4.98	2.95 –8.40
	>= 70 years	6.64	4.33 –10.17
Socio Economic Status	Upper	1.00	
	Upper Middle	1.24	0.79 -1.96
	Lower Middle	1.75	1.18 –2.60
	Lower	2.33	1.52 –3.55
Literacy status	Educated to secondary and above	1.0	
	Completed primary	1.44	1.10-1.89
	Illiterate/ Less than primary	1.89	1.27-2.83
Ethnicity	Sinhala	1.0	
	Tamil	0.7	0.52 –0.94
	Moors	0.58	0.27 –1.20

CONCLUSIONS

This was the first ever national blindness and visual impairment survey in Sri Lanka. Prior to this survey, a localized survey in the Central province in the Kandy region had been undertaken within the last decade. The present study therefore provides valuable information to the national Vision2020 secretariat for evaluating the current status and for planning needs-based eye care services across the country such that the elimination of avoidable blindness is achieved by 2020 in Sri Lanka.

The findings from the survey can be extrapolated to the entire country as the sample was consistent with the demographic characteristics of Sri Lanka. The sample was identified using population proportionate to size principles and is therefore reflective of the current situation in Sri Lanka. The overall response rate of 86.1% for examination among the enumerated population also gives confidence in using the data for the entire country.

More women than men presented for an eye examination. This meant that there was some selection bias based on sex. However, census data from Sri Lanka shows that compared to most other low and middle income countries, the male-female sex differential is more pronounced in Sri Lanka as life expectancy data show that women outlive men by more than 10 years. This could also be a reason for the higher examination rate among females, though selection bias cannot be ruled out.

The prevalence of blindness in Sri Lanka was 1.7% (95% CI: 1.3 –1.99) among those aged 40+ years. The highest prevalence of blindness was in Uva, Eastern, North Western and Northern provinces while the lowest was in the Western and Southern provinces. Data provides sufficient evidence for program planners to identify priority regions for specific interventions to reduce the prevalence of blindness. The study also shows that the current program interventions are effective as the overall prevalence of blindness and visual impairment is much lower than many other low and middle income countries including neighbouring countries in South Asia. It was also observed that 90% of the causes of blindness are avoidable, with cataract and uncorrected refractive errors being the predominant causes of blindness. Cataract surgical coverage was significantly higher than many other low and middle income countries. This corroborates the observation that most of the operable cataract blind persons are receiving surgical services. There is a need to sustain the current efforts and augment the program in specific provinces in the country to achieve successful outcomes by 2020. At the same time, the Sri Lanka example where public-funded services provide primary, secondary and tertiary eye care and ensure successful inputs should be an apt case study for many other countries.

Visual outcomes after cataract surgery can be improved further as is evident from the present study. There is a need to orient ophthalmologists on proper case selection, operative standards and post-operative care. It will be beneficial if self-monitoring of cataract surgical outcomes are emphasized by the Vision 2020 secretariat and the College of Ophthalmologists, as this is in the interest of the operating surgeons as the process can be kept confidential and only the operating surgeon is able to view their surgical outcomes.

Barriers to access highlighted costs of accessing services for ocular morbidity, refractive errors as well as cataract. It has to be realized that the provision of a free surgical or optical service is an essential input but unless costs related to transportation and medications which are usually out-of-pocket expenditures also need to be factored in for an effective service. Universal health care including universal eye care is the way forward and many countries are investing in this approach. Such an approach should consider the out-of-pocket expenditures which include inpatient care costs for the service to be all-encompassing and result in a higher degree of success than only considering costs of in-patient care. Priority in subsidising patient costs should be given to women, older aged populations, those with

lower educational attainment and populations from the lower socio-economic strata. This will improve equity in service delivery and support the achievement of the universal eye care coverage.

DISABILITY

The all-age prevalence of disability was 3.17% [95% CI: 2.87 –3.50%]. Determinants of disability included sex, literacy, socio-economic status, place of residence and religion. Most of these determinants are not modifiable. What is modifiable however are the barriers to activity limitations including the attitude of the community and peer groups which is stigmatizing. Sensitization of the community on the ability of persons with disability have potential for excellent work output and can contribute significantly to the nation's development is an urgent necessity. Addressing social stigma with the strong focus on population groups that may experience double or triple discrimination due to their disability, gender and lower social status will be essential for future disability-related policies and programmes.

APPENDIX 1: Number of clusters in each province and district in Sri Lanka

Province/District	Divisional secretariat	No. of Clusters	Type of cluster	Cluster Name
WESTERN		**19**		
Colombo		**8**		
Colombo	Colombo		Urban	Modara
Colombo	Kolonnawa		Urban	Sedawatta
Colombo	Seethawaka		Urban	Kudagama
Colombo	Sri Jayawardanapura		Urban	Pagoda East
	Kotte			
Colombo	Dehiwala		Urban	Dehiwala West
Colombo	Moratuwa		Urban	EgodaUyana N
Colombo	Homagama		Rural	Homagama Rural
Colombo	Padukka		Rural	Waga East
Gampaha		**7**		
Gampaha	Gampaha		Urban	Morenna
Gampaha	Katana		Rural	Kovinna
Gampaha	Mirigama		Rural	Wandurawa
Gampaha	Wattala		Rural	Dikovita
Gampaha	Gampaha		Rural	Parakandeniya
Gampaha	Dompe		Rural	Dompe
Gampaha	Kelaniya		Rural	Galborella
Kalutara		**4**		
	Panadura		Rural	Kiriberiya
	Ingiriya		Rural	Kandanapitiya
	Kalutara		Rural	Thekkawatta
	Mathugama		Rural	Keeranthidiya
CENTRAL		**8**		
Kandy		**4**		
Kandy	Kandy Four GGK		Urban	Bogambara
Kandy	Pathadumbara		Rural	Eriyagasthenna
Kandy	Kandy Four GGK		Rural	UdaPeradeniya
Kandy	Pathahewaheta		Rural	Pooliyadda
Matale		**2**		
Matale	Pallepola		Rural	Bomeruwa
Matale	Ukuwela		Rural	WariyapolaWatta
NuwaraEliya		**2**		
NuwaraEliya	Walapane		Rural	Brookside
NuwaraEliya	Ambagamuwa		Rural	Injustry
SOUTHERN		**8**		
Galle		**3**		
Galle	Niyagama		Rural	Hattaka
Galle	Gonapeenuwala		Rural	Dodamkahavila
Galle	Habaraduwa		Rural	Bonavistawa

Province/District	Divisional secretariat	No. of Clusters	Type of cluster	Cluster Name
Matara		**3**		
Matara	Kotapola		Rural	Deniyaya
Matara	Welipitiya		Rural	Nalawana
Matara	Weligama		Rural	MirissaUdumulla
Hambantota		**2**		
Hambantota	Ambalantota		Rural	Thawaluvila
Hambantota	Tangalle		Rural	Kahandawa
NORTHERN		**6**		
Jaffna		**2**		
Jaffna	Valikamam North		Rural	Mallakam Centre
Jaffna	Thenmaradchi (Chavak.)		Rural	Kaithady North
Kilinochchi		**1**		
Kilinochchi	Poonakary		Rural	Nachchikkuda
Mannar*		**1**		
Mannar Town			Rural	Uyirtharayankulam
Vavuniya		**1**		
Vavuniya	Vavuniya		Rural	Pandarikkulam
Mullaitivu*		**1**		
Mullaitivu*	Oddusuddan		Rural	Muthuvinayagarpuram
EASTERN		**5**		
Batticaloa		**2**		
Batticaloa	EravurPattu		Rural	Iyankerny Tamil
Batticaloa	Manmunai S & EruvilPattu		Rural	Kaluthawalai 2
Ampara		**2**		
Ampara	Uhana		Rural	Himidurawa
Ampara	Damana		Rural	Diviyagala
Trincomalee		**1**		
Trincomalee	Gomarankadawala		Rural	Pulikandikulama
NORTH WESTERN		**8**		
Kurunegala		**5**		
Kurunegala	Galgamuwa		Rural	Wadugama
Kurunegala	Ibbagamuwa		Rural	Siyambalawehera
Kurunegala	Panduwasnuwara East		Rural	Dematawa
Kurunegala	Rideegama		Rural	Bambaragahakanda
Kurunegala	Pannala		Rural	Elabadagama North
Puttalama		**3**		
Puttalama	Kalpitiya		Rural	Palakudawa
Puttalama	Anamaduwa		Rural	Thalgaswewa
Puttalama	Nattandiya		Rural	Dunkannawa

Province/District	Divisional secretariat	No. of Clusters	Type of cluster	Cluster Name
NORTH CENTRAL		**4**		
Anuradhapura		**3**		
Anuradhapura	Medawachchiya		Rural	Etaweeragollewa
Anuradhapura	Mihinthale		Rural	Ukkulankulama
Anuradhapura	Thalawa		Rural	Galmaduwa
Polonnaruwa		**1**		
Polonnaruwa	Hingurakgoda		Rural	Bathgampattuwa
UVA		**4**		
Badulla		**3**		
Badulla	Lunugala		Rural	Alakolagala
Badulla	Welimada		Rural	Divurumgama
Badulla	Haldummulla		Rural	Kolongasthenna
Monaragala		**1**		
Monaragala	Bibile		Rural	Kanulwela
SABARAGAMUWA		**6**		
Ratnapura		**3**		
Ratnapura	Ratnapura		Rural	Kudawa
Ratnapura	Elapatha		Rural	Pallegedara
Ratnapura	Embilipitiya		Rural	Miriswelpatha
Kegalle		**3**		
Kegalle	Mawanella		Rural	Batawala
Kegalle	Galigamuwa		Rural	Lahupana
Kegalle	Yatiyanthota		Rural	Seepoth
Total		**68**		

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