Provisioning Ophthalmic Care for Remote Rural Indian Populations

Zeena Johar*

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* President
IKP Centre for Technologies in Public Health
Chennai, India
zeena.johar@ictph.org.in
www.ictph.org.in

Introduction:

The estimated prevalence of blindness (also refer Annexure-1) in 1990 ranged from 0.08% of children to 4.4% of persons aged over 60 years, with an overall global prevalence of 0.7%. As shown in *Fig. 1* of the estimated 45 million cases of blindness by 1996, approximately 60% were due to either cataract (16 million people) or refractive errors. A further 15% were due to trachoma, vitamin A deficiency or onchocerciasis, with another 15% due to diabetic retinopathy or glaucoma. The remaining 10% of cases were attributable to age-related macular degeneration and other diseases. In view of the proportion of treatable eye diseases or treatable causes of blindness, such as cataract, trachoma, onchocerciasis and some eye conditions in children, it was estimated that 75% of all blindness in the world could have been avoided. (VISION - 2020 Global Initiative for the Elimination of Avoidable Blindness Action Plan 2006 - 2011, 2007) (Blindness in the Elderly, Editorial, 2008)

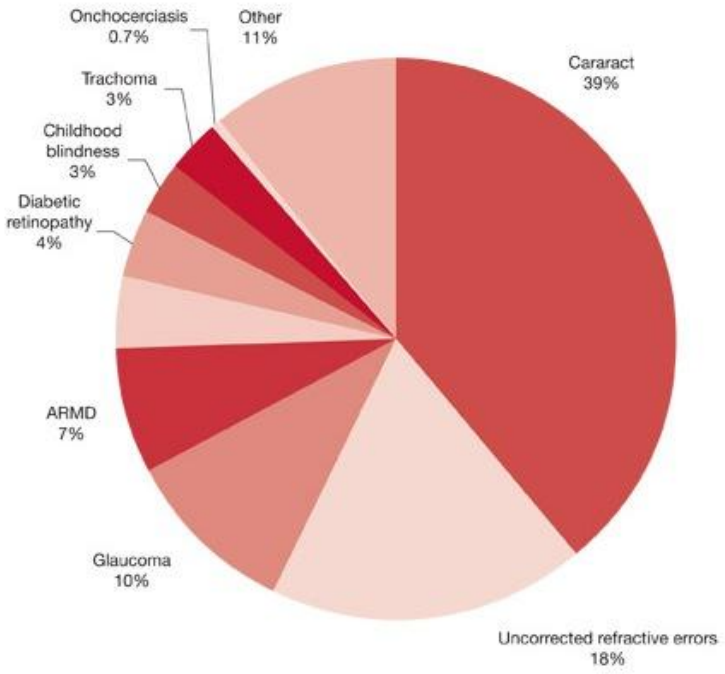

Figure 1: Global causes of blindness due to eye diseases and uncorrected refractive errors (VISION - 2020 Global Initiative for the Elimination of Avoidable Blindness Action Plan 2006 - 2011, 2007)

The risk factors for loss of vision are age, gender, poverty, and poor access to health care. It is estimated that more than 82.2% of all blind individuals are 50 or older. The burden for visual impairment accounts for approximately 3% of the total global burden of disease and 9% of total years lived with disability in 2001 (Loss of Vision and Hearing, Disease Control Priorities in Developing Countries, Second Edition, 2006). A comprehensive national assessment of the economic cost of visual impairment conducted in Australia, with five principal eye conditions – cataract, age-related macular degeneration, glaucoma, diabetic retinopathy and refractive error accounted for about 75% of all visual impairment (VISION - 2020 Global Initiative for the Elimination of Avoidable Blindness Action Plan 2006 - 2011, 2007). Multiple community based screening (Quigley, Park,

Tracey, & Pollack, 2002), eye injury prevention (Luque, et al., 2007), and community based provisioning (American Optometric Association Community Health Centre Committee, Michelle Proser, Peter Shin, 2008) (Vision Centres, 2010) experiences guide towards adopting a comprehensive outlook catering to community ophthalmic needs.

The ICTPH Health Systems (Johar, 2010) strategy aims to facilitate a comprehensive healthcare delivery model for remote rural Indian population. With a unique community based health worker – ICTPH Guide provisioning screening and preventive healthcare services and a village based nurse-managed Rural Micro Health Centre (RMHC) provides a unique opportunity to explore a multi-dimensional approach. With individual health at the crux, establishing various preventive, diagnostic and curative interventions aims to achieve better health outcomes. This paper attempts to outline ICTPH's strategy to integrate primary ophthalmic healthcare services in its unique healthcare delivery model.

Anatomy, Physiology and Pathophysiology of the Eye:

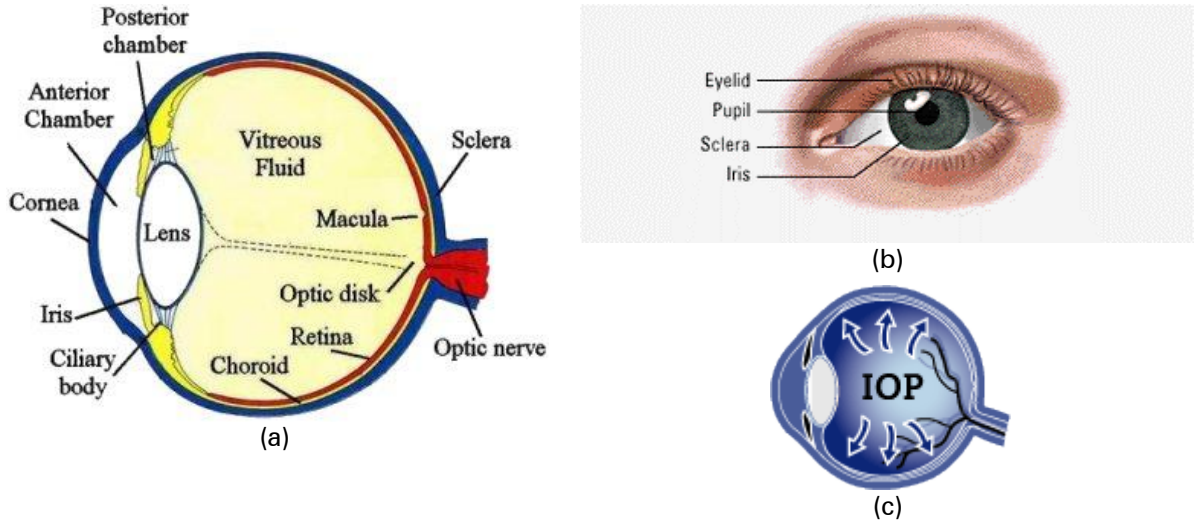

Figure 2: (a) & (b): Anatomy of the Human Eye (c): IOP-Intra Ocular Pressure

Light waves from an object enter through the cornea, progressing through the pupil, to the crystalline lens eventually converging onto the retina. The small central area of the retina is the macula, which provides the best vision of any location in the retina. Within the layers of the retina, light impulses are changed into electrical signals. Then they are sent through the optic nerve, along the visual pathway, to the occipital cortex at the posterior (back) of the brain. Here, the electrical signals are interpreted or "seen" by the brain as a visual image (Anatomy, Physiology & Pathology of the Human Eye, 1998-2010). Rod and cone cells in the retina allow conscious light perception and vision including color differentiation and the perception of depth.

1. **Refractive Errors** (also refer Annexure-2) - Myopia, Hypermetropia, Astigmatism and Presbyopia result in an unfocussed image falling on the retina. Uncorrected refractive errors, which affect persons of all ages and ethnic groups, are the main cause of visual impairment. There are estimated to be 153 million people with visual impairment due to uncorrected refractive errors, i.e. presenting visual acuity < 6/18 in the better eye, excluding presbyopia. The most frequently

used options for correcting refractive errors are: spectacles, the simplest, cheapest and most widely used method; contact lenses, which are not suitable for all patients or environments; and corneal refractive surgery, which entails reshaping the cornea by laser. (VISION - 2020 Global Initiative for the Elimination of Avoidable Blindness Action Plan 2006 - 2011, 2007)

The steps in the provision of refraction services are (VISION - 2020 Global Initiative for the Elimination of Avoidable Blindness Action Plan 2006 - 2011, 2007):

- **Case Detection**: Identification of individuals with poor vision that can be improved by correction;
- **Eye Examination**: Identify coexisting eye conditions needing care;
- **Refraction**: Evaluation of the patient to determine the correction required;
- **Dispensing**: Provision of the correction, ensuring a good fit of the correct prescription; and
- **Follow-up**: ensuring compliance with prescription and good care of the correction, repair or replacement of spectacles if needed.

A. Spherical Refractive Errors

- **Myopia (nearsightedness)** is a refractive defect of the eye in which collimated light produces image focus in front of the retina when accommodation is relaxed. For those with myopia, far away objects appear blurred and near objects appear clearly. Eye care professionals most commonly correct myopia through the use of corrective lenses, such as glasses or contact lenses. It may also be corrected by refractive surgery, but this does have many risks and side effects. The corrective lenses have a negative optical power (*i.e.* are concave) which compensates for the excessive positive diopters of the myopic eye. A diagnosis of myopia is typically confirmed during an eye examination by an ophthalmologist, optometrist or orthoptist. Frequently an autorefractor or retinoscope is used to give an initial objective assessment of the refractive status of each eye, then a phoropter is used to subjectively refine the patient's eyeglass prescription.

- **Hyperopia**, also known as farsightedness, longsightedness or hypermetropia, is a defect of vision caused by an imperfection in the eye (often when the eyeball is too short or the lens cannot become round enough), causing difficulty focusing on near objects, and in extreme cases causing a sufferer to be unable to focus on objects at any distance. People with hyperopia can experience blurred vision, asthenopia, accommodative dysfunction, binocular dysfunction, amblyopia, and strabismus.

- **Presbyopia** is a condition where the eye exhibits a progressively diminished ability to focus on near objects with age. Presbyopia's exact mechanisms are not known with certainty; the research evidence most strongly supports a loss of elasticity of the crystalline lens, although changes in the lens's curvature from continual growth and loss of power of the ciliary muscles (the muscles that bend and straighten the lens) have also been postulated as its cause. Like gray hair and wrinkles, presbyopia is a symptom caused by the natural course of aging. The

first signs of presbyopia--eyestrain, difficulty seeing in dim light, problems focusing on small objects and/or fine print--are usually first noticed between the ages of 40-50.

B. Cylindrical Refractive Errors:

- **Astigmatism** is an optical defect in which vision is blurred due to the inability of the optics of the eye to focus a point object into a sharp focused image on the retina. This may be due to an irregular or toric curvature of the cornea or lens. There are two types of astigmatism: regular and irregular. Irregular astigmatism is often caused by a corneal scar or scattering in the crystalline lens and cannot be corrected by standard spectacle lenses, but can be corrected by contact lenses. Regular astigmatism arising from either the cornea or crystalline lens can be corrected by a toric lens. The astigmatic optics of the human eye can often be corrected by spectacles, hard contact lenses or contact lenses that have a compensating optic, cylindrical lens (i.e. a lens that has different radii of curvature in different planes), or refractive surgery.

2. Cataract is a cloudy area in the lens of the eye. Adult cataracts usually develop very gradually with advancing age and may run in families. (Cataract: MedlinePlus Medical Encyclopedia, 2010) The main non-modifiable risk factor is ageing. Other frequently associated risk factors are injury, certain eye diseases (e.g. uveitis), diabetes, ultraviolet irradiation and smoking. Cataract in children is mainly due to genetic disorders. Adult cataracts are classified as immature cataract -- lens has some remaining clear areas; mature cataract -- completely cloudy or opaque lens; hypermature cataract -- lens tissues are breaking down and leaking through the surface covering, damaging other structures in the eye. Most people develop some mild clouding of the lens after age 60. About 50% of people ages 65-74, and about 70% of those 75 and older have cataracts that affect their vision (also refer Annexure-7). Cataract interventions, primarily surgery has been cited as cost effective as immunization and can significantly and rapidly reduce avoidable blindness. Surgery to remove the opacified lens is the only effective treatment for cataracts. Neither diet nor medications have been shown to stop cataract formation (Loss of Vision and Hearing, Disease Control Priorities in Developing Countries, Second Edition, 2006).

3. Diabetic Retinopathy: Retinopathy (damage to the retina) caused by complications of diabetes mellitus, can eventually lead to blindness. Small blood vessels – such as those in the eye – are vulnerable to poor blood sugar (blood glucose) control. An over accumulation of glucose and/or fructose damages the tiny blood vessels in the retina. During the initial non-proliferative stage diabetic retinopathy (NPDR), most people do not notice any change in their vision. Some people develop a condition called macular edema – when damaged blood vessels leak fluid and lipids onto the macula. The fluid makes the macula swell, blurring vision. As the disease progresses, severe non-proliferative diabetic retinopathy enters an advanced, or proliferative, stage when blood vessels proliferate (i.e. grow). The lack of oxygen in the retina causes fragile, new, blood vessels to grow along the retina and in the vitreous humour that fills the inside of the eye. Without timely treatment, these new blood vessels can bleed, cloud vision, and destroy the retina. Regular dilated eye examinations are effective for detection and monitoring of asymptomatic vision-threatening diabetic retinopathy (Cheung, Mitchell, & Wong, 2010).

4. **Glaucoma** is a disease in which the optic nerve is damaged, leading to progressive, irreversible loss of vision. It is often, but not always, associated with increased pressure of the fluid in the eye. Ocular hypertension[†] (increased pressure within the eye – above 21 mmHg or 2.8kPa) is the largest risk factor. Those at risk are advised to have a dilated eye examination at least once a year. WHO estimates about 60.5 million will have glaucoma by the year 2010 (also refer Annexure-3)

5. **Age related macular degeneration** is a medical condition which usually affects older adults resulting in loss of vision in the center of the visual field (the macula) because of damage to the retina. It occurs in "dry" and "wet" forms. It is a major cause of visual impairment in older adults (>50 years) (also refer Annexure-8). Macular degeneration can make it difficult or impossible to read or recognize faces, although enough peripheral vision remains to allow other activities of daily life.

6. **Onchocerciasis**, also known as river blindness and Robles' Disease (also refer Annexure-5), is a parasitic disease and the world's second-leading infectious cause of blindness. Onchocerciasis is endemic in 28 countries in tropical Africa, where 99% of infected people live. (Loss of Vision and Hearing, Disease Control Priorities in Developing Countries, Second Edition, 2006)

7. **Trachoma** (rough eye) is an infectious eye disease, and the leading cause of the world's infectious blindness. Globally, 41 million people suffer from active infection and nearly 8 million people are visually impaired as a result of this disease (also refer Annexure-4). Globally this disease results in considerable disability. Trachoma is caused by *Chlamydia trachomatis* and it is spread by direct contact with eye, nose, and throat secretions from affected individuals, or contact with inanimate objects, such as towels and/or washcloths, that have had similar contact with these secretions. Flies can also be a route of mechanical transmission. Untreated, repeated trachoma infections result in entropin - a painful form of permanent blindness when the eyelids turn inward, causing the eyelashes to scratch the cornea. Children are the most susceptible to infection due to their tendency to easily get dirty, but the blinding effects or more severe symptoms are often not felt until adulthood. Most commonly children with active trachoma will not present with any symptoms as the low grade irritation and ocular discharge is just accepted as normal. However, further symptoms may include - eye discharge, swollen eyelids, trichiasis (turned-in eyelashes), swelling of lymph nodes in front of the ears, seeing bright lights, increased heart rate, further ear, nose and throat complications. WHO recommends an integrative approach to trachoma control through its SAFE strategy (surgery, antibiotics to control the infection, facial cleanliness and environmental improvements). (Loss of Vision and Hearing, Disease Control Priorities in Developing Countries, Second Edition, 2006)

8. **Conjunctivitis** (also called **pink eye** or **madras eye**) refers to inflammation of the conjunctiva (the outermost layer of the eye and the inner surface of the eyelids). It is most commonly due to an infection (usually viral, but sometimes bacterial) or an allergic reaction.

[†] **Ocular hypertension** (OHT) is intraocular pressure higher than normal (10 mmHg – 21 mmHg) in the absence of optic nerve damage or visual field loss.

9. **Vitamin A deficiency** is a lack of vitamin A in humans. It is common in developing countries but rarely seen in developed countries. **Night blindness** is one of the first signs of vitamin A deficiency. The prevalence of night blindness due to vitamin A deficiency is also high among pregnant women in many developing countries. Vitamin A deficiency also contributes to maternal mortality and other poor outcomes in pregnancy and lactation. Vitamin A deficiency also diminishes the ability to fight infections. In 1993, WHO estimates a total of 13.8 million children having some degree of eye damage because of vitamin-A (also refer Annexure-6). However the number of children with actual blindness is much lower – less than 500,000 in 1992. Cost effectiveness studies of vitamin-A supplementation focus only on deaths averted unrelated to blindness, but this public health intervention appears to be cost effective. (Loss of Vision and Hearing, Disease Control Priorities in Developing Countries, Second Edition, 2006)

10. **Xerophthalmia** is a medical condition in which the eye fails to produce tears. Xerophthalmia is caused by a severe vitamin-A deficiency is described by pathologic dryness of the conjunctiva and cornea. If untreated, it can lead to corneal ulceration and ultimately blindness as a result of corneal damage. Xerophthalmia usually affects children under nine years old. Symptomatic treatment of includes use of artificial tears in the form of eye drops, increasing humidity of the environment with humidifiers, and wearing wrap around glasses when outdoors. Treatment of deficiency can be accomplished with a Vitamin-A or multivitamin supplement or by eating foods rich in Vitamin-A. Treatment with supplements and/or diet can be successful until the disease progresses as far as corneal ulceration, at which point only an extreme surgery can offer a chance of returning sight

Population Level Screening Recommendation:

The aim of screening for a disease or a risk factor is to reduce the burden of the disease in the community including incidence of disease, morbidity from the disease or mortality. This is achieved by intervening to reduce individual risk of the disease or detecting the disease earlier on average than is usually the case in the absence of screening and thereby improving disease outcome. Optimizing clinical management of the condition and patient outcomes in all healthcare providers prior to participation in a screening program is core to early detecting and early treatment. (Population Based Screening Framework, Screening Subcommittee, Australian Population Health Development Principal Committee, 2008)

The U.S. Preventive Services Task Force (USPSTF) reports:

- Insufficient evidence to recommend for or against screening adults for glaucoma (USPTF Screening for Glaucoma, Topic Page, 2005)

- Insufficient current evidence to assess the balance of benefits and harms of screening for visual acuity for the improvement of outcomes in older adults (USPTF - Screening for Impaired Visual Acuity in Older Adults, Topic Page, 2009)

- Grade-B recommendation for screening to detect strabismus[‡], amblyopia[§], and defects in visual acuity in children younger than age 5 years (USPTF Screening for Visual Impairment in Children Younger than Age 5 Years, Topic Page, 2004)

Limited evidence reveals screening for impaired visual acuity in older adults in primary care settings is not associated with improved visual or other clinical outcomes and may be associated with unintended harms such as increased risk of falls. (Chou, Dana, & Bougatsos, 2009)

Vision Interventions based at the Rural Micro Health Centre (Bickley & Szilagyi, 2009) (Vision Centres, 2010)

Provisioning ophthalmic services at primary-care entails refractive error correction (myopia, hypermetropia, astigmatism, and presbyopia), cataract – detection, management and referral for surgical intervention, and managing chronic disease complications such as diabetic retinopathy and glaucoma through intraocular pressure assessment using tonometry (also refer Annexure 14) and regular fundus examination using ophthalmoscopy (also refer Annexure 12 & 13).

Ophthalmic Examination Protocol (Bickley & Szilagyi, 2009):

- *Visual Health History*: Check for common symptoms - headache, change in vision (worse during close work or distance), scotomas (partial alteration in one's field of vision), double vision, sudden bilateral vision loss, blurred vision, flashing light across the field of vision, prescription glass usage.

- *Visual Acuity/Refraction*: Test the acuity of central vision use a Snellen Chart (also refer Annexure 9). Using the trial lens set and a trial frame (also refer Annexure 10), assess the appropriate corrective prescription for myopia, hypermetropia, astigmatism. A similar assessment procedure may be used to assess the corrective prescription for presbyopia. An autorefractor along with a phoropter may also be used in advanced clinical settings automating corrective prescription estimation.

- *Visual Fields*: Test for visual field by confrontation. Small visual field defects and enlarged blind spots require a finer stimulus.

[‡] **Strabismus** (to squint, squinting, squint-eyed) is a condition in which the eyes are not properly aligned with each other. It typically involves a lack of coordination between the extraocular muscles, preventing the gaze of each eye to the same point in space and preventing proper binocular vision, which may adversely affect depth perception or a disorder of the brain in coordinating the eyes. Advanced strabismus is usually treated with a combination of eyeglasses or prisms, vision therapy, and surgery, depending on the underlying reason for the misalignment.

[§]**Amblyopia** (lazy eye) is a disorder of the visual system that is characterized by poor or indistinct vision in an eye that is otherwise physically normal, or out of proportion to associated structural abnormalities. The problem is caused by either no transmission or poor transmission of the visual stimulation through the optic nerve to the brain for a sustained period of dysfunction or during early childhood thus resulting in poor or dim vision. Detecting the condition in early childhood increases the chance of successful treatment. Treatment of *strabismic* or *anisometropic amblyopia* consists of correcting the optical deficit (wearing the necessary spectacle prescription) and often forcing use of the amblyopic eye, either by patching the good eye, or by instilling topical atropine in the eye with better vision.

- *Eyes, Eyebrows, Eyelids, Lacrimal Apparatus*: Check for position and alignment of the eyes, assess eye protrusion. Check for any scaliness of the underlying skin for the eyebrows; note the position of the eyelids in relation to the eyeballs. Inspect for width of the palpebral fissures, edema of the lids, and color of the lids, lesions, condition and direction of the eyelashes, adequacy with which the eyelids close. Inspect regions of the lacrimal gland and lacrimal sac for swelling. Look for excessive tearing or dryness of the eyes.

- *Conjunctiva and Sclera*: Depress both lower lids with the thumb, exposing the sclera and conjunctiva – inspect for color and vascular pattern. Look for any nodules or swelling.

- *Cornea and Lens:* With oblique lighting, inspect the cornea for opacities, and note any opacity in the lens that may be visible through the pupil.

- *Pupils:* Inspect for size, shape and symmetry. Test the pupillary reaction to light – direct reaction (pupillary constriction in the same eye), consensual reaction (pupillary constriction in the opposite eye)

- *Extra-Ocular Movements*: Inspect reflections in the cornea. Perform the cover-uncover test to assess conjugate movements. To test the six extra-ocular movements (EOMs), assess the patient to follow finger or pencil as one sweeps through the six cardinal directions. Test for convergence.

- *Ophthalmoscopic Examination*: Dilating the pupils, to examine the optic disc and the retina using an ophthalmoscope (also see Annexure 12 & 13). Inspect the optic disc – the sharpness or clarity of the outline disc. The color of the disc (normal – yellowish orange to creamy pink), the size of the central physiologic cup, if present. The comparative symmetry of the eyes and findings in the fundi. Assess for Papilledema (swelling of the optic disc and anterior bulging of the physiologic disc). Papilledema often signals serious disorders of the brain, such as meningitis, subarachnoid hemorrhage, trauma, and mass lesions, so searching for this important disorder is priority during all fundoscopic examinations. Assess light reflex (reflection) – arteries (bright), veins (inconspicuous or absent).

The current infrastructure of a village-based Rural Micro Health Centre allows for suitable infrastructure advancement, facilitating ophthalmic capability, servicing a population of 10,000 people. To service the above listed examination protocol, primarily a trial lens set + trial frame, a streak retinoscope and an ophthalmoscope are essential (also refer Annexure 16). For a higher order fundus examination a slit-eye lamp may be appropriate, but the substantial cost implication requires a careful community need assessment.

The nurse-managed Rural Micro Health Centres (RMHC) allows for multi-tasking/skill building a nurse to provision multiple diagnostic capabilities (Johar, 2010) at the village level inclusive of primary-level ophthalmic interventions. Given refractive error shares the largest disease burden, dispensing corrective prescription glasses may be essential. Through the RMHC network, a careful skill building exercise will allow servicing ophthalmic requirement of the local population, along with optimizing task allocation across the RMHC network (e.g. combined corrective prescription glass dispensing facility across a network of five RMHCs servicing a population of 50,000 people).

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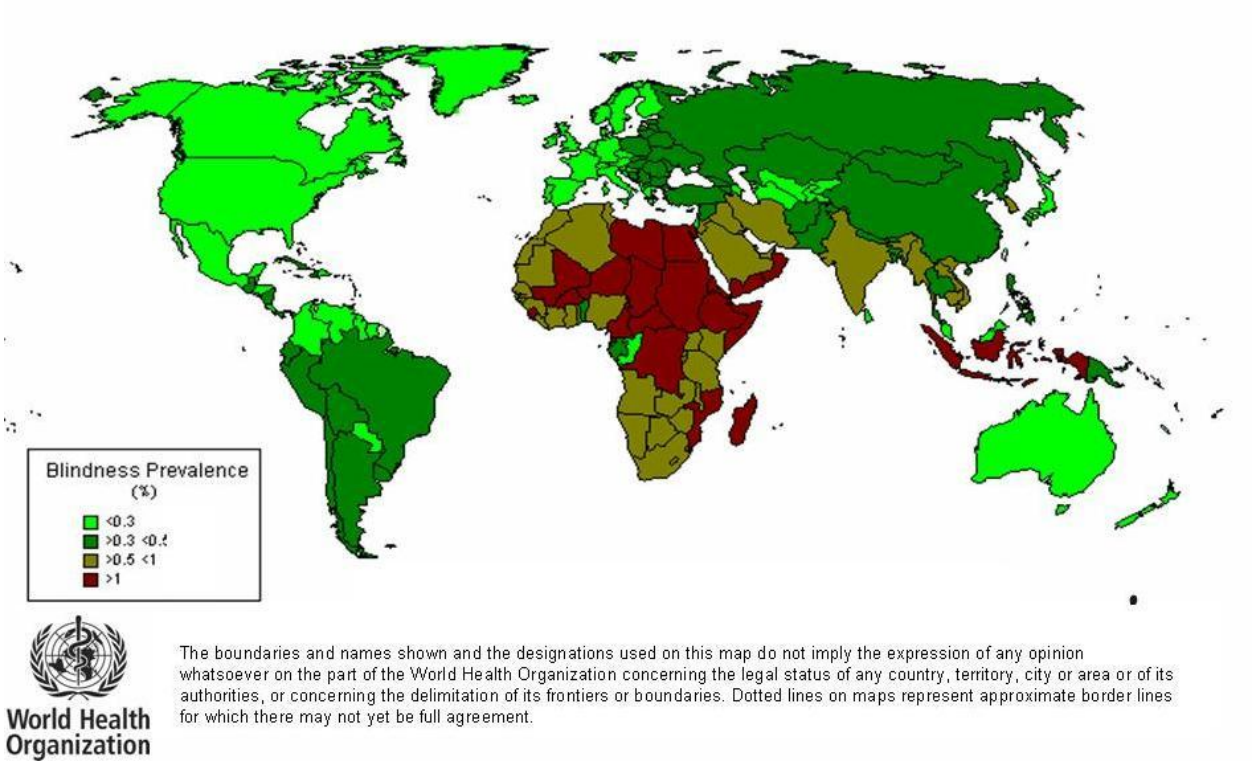
Annexure -1: *(Blindness prevalence)*

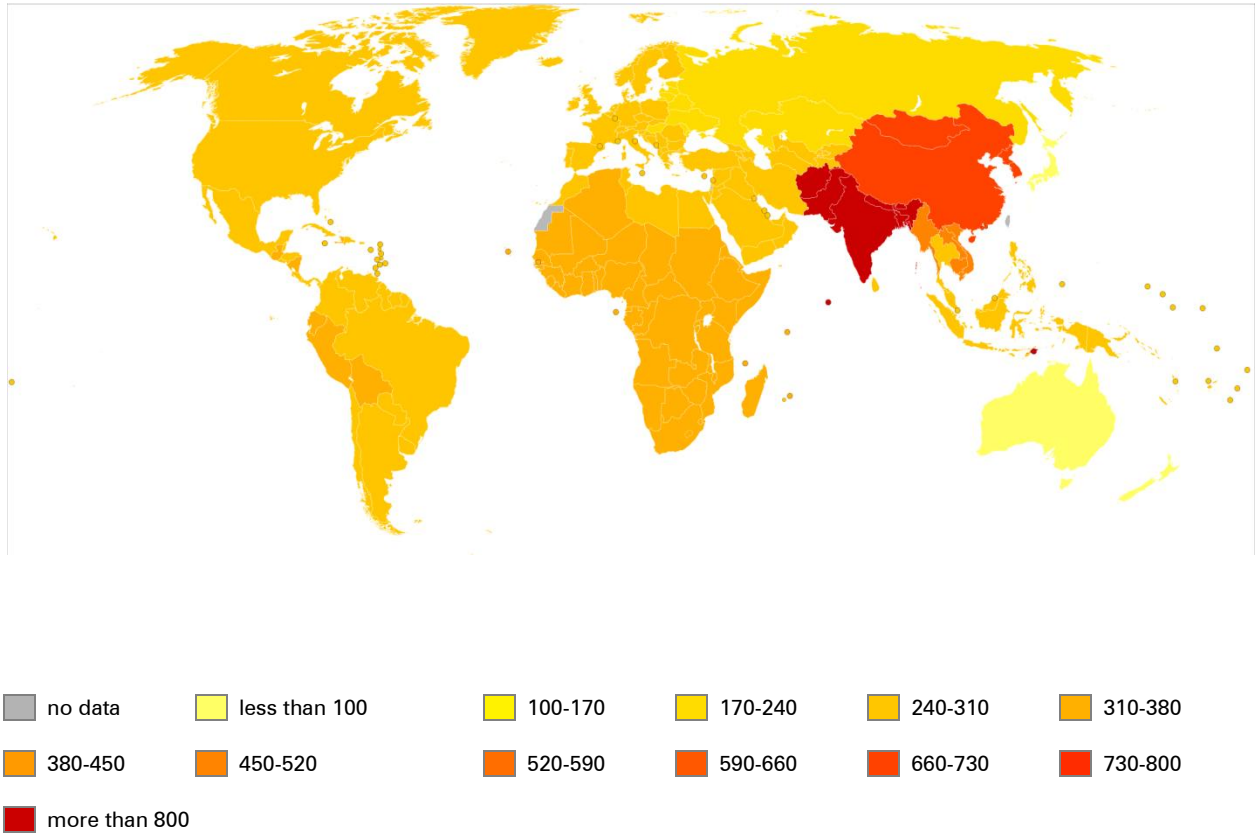
Source: http://www.who.int/blindness/data_maps/blindness.jpg



Annexure-2: *(Refractive Errors)*

Age-standardised disability-adjusted life year (DALY) rates from refractive errors by country (per 100,000 inhabitants).

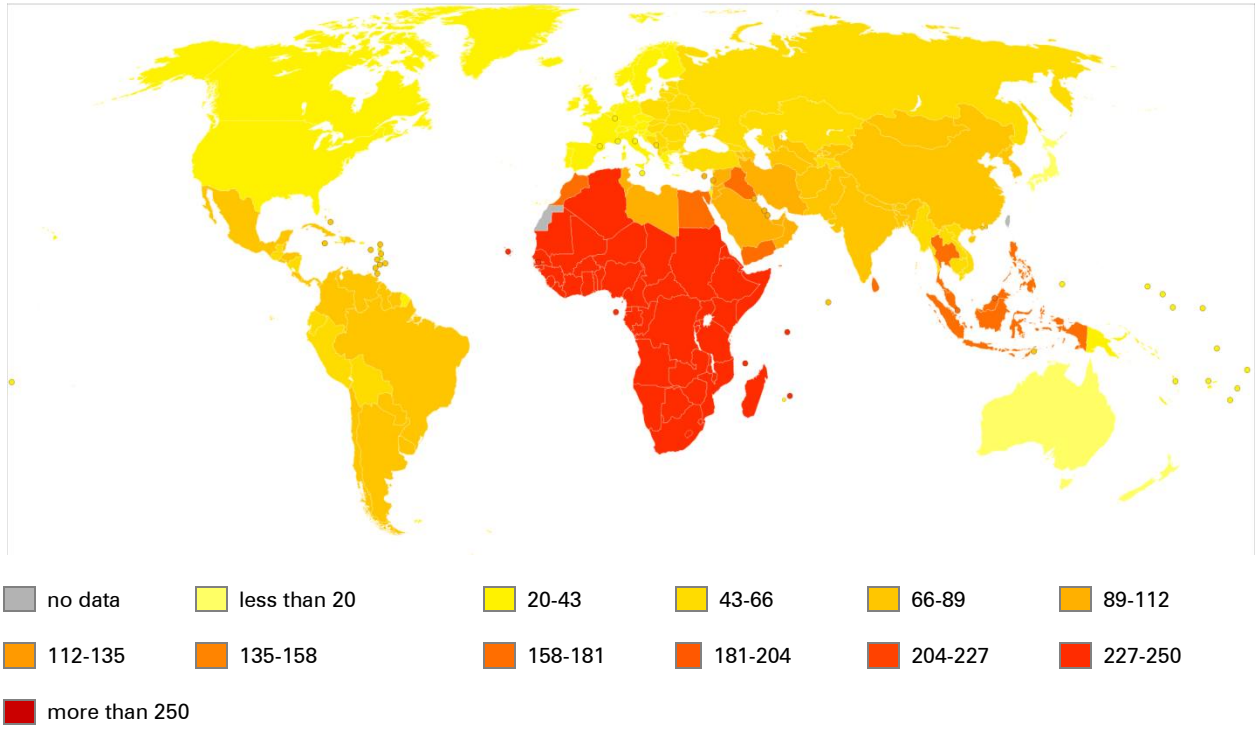
Source: *Death and DALY estimates for 2004 by cause for WHO Member States (Persons, all ages)*



Annexure – 3: *(Glaucoma)*

Age-standardised disability-adjusted life year (DALY) rates from Glaucoma by country (per 100,000 inhabitants).

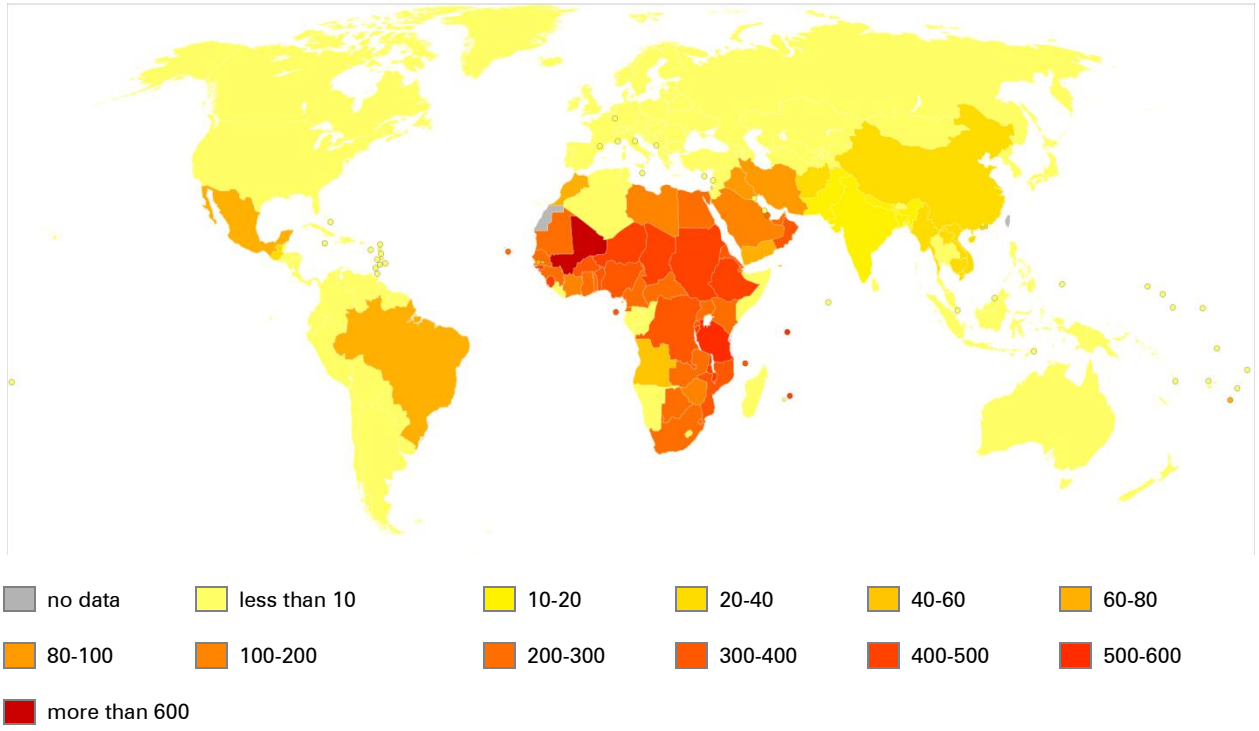
Source: *Death and DALY estimates for 2004 by cause for WHO Member States (Persons, all ages)*



Annexure – 4: *(Trachoma)*

Age-standardised disability-adjusted life year (DALY) rates from Trachoma by country (per 100,000 inhabitants)

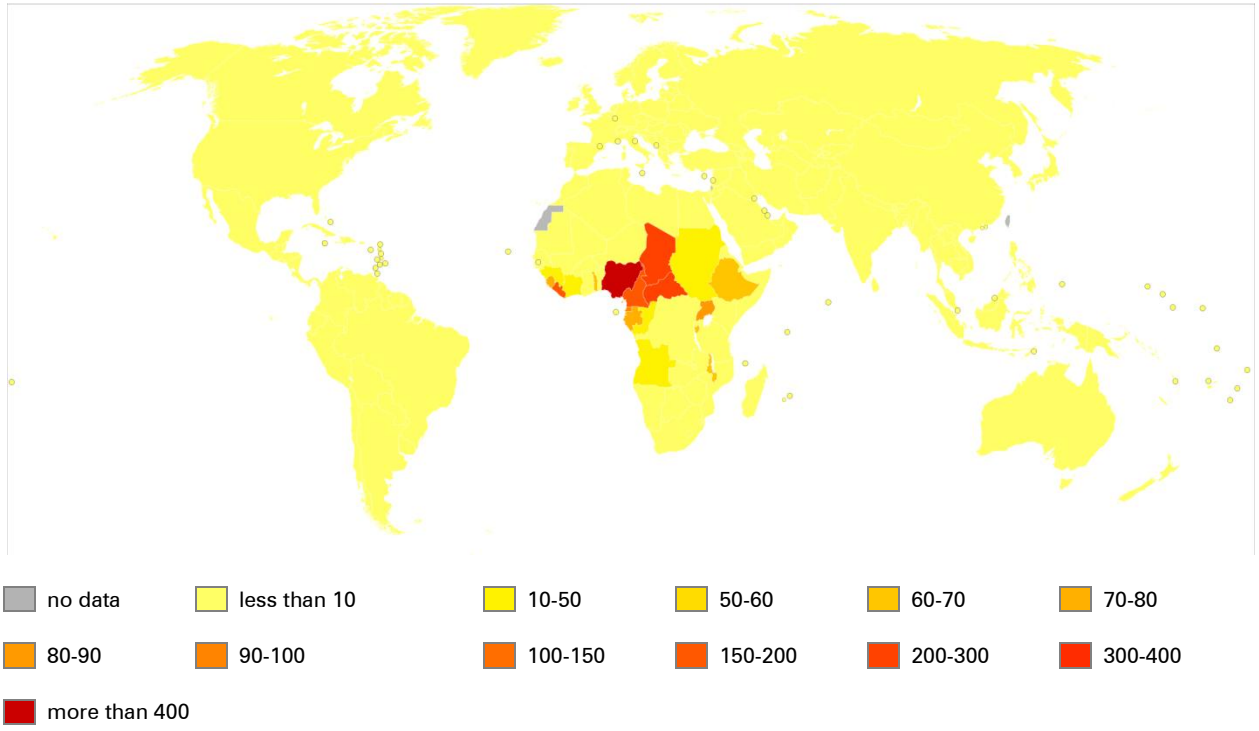
Source: *Mortality and Burden of Disease estimates for WHO member states in 2002*



Annexure -5: *(Onchocerciasis)*

Age-standardised disability-adjusted life year (DALY) rates from Onchocerciasis by country (per 100,000 inhabitants)

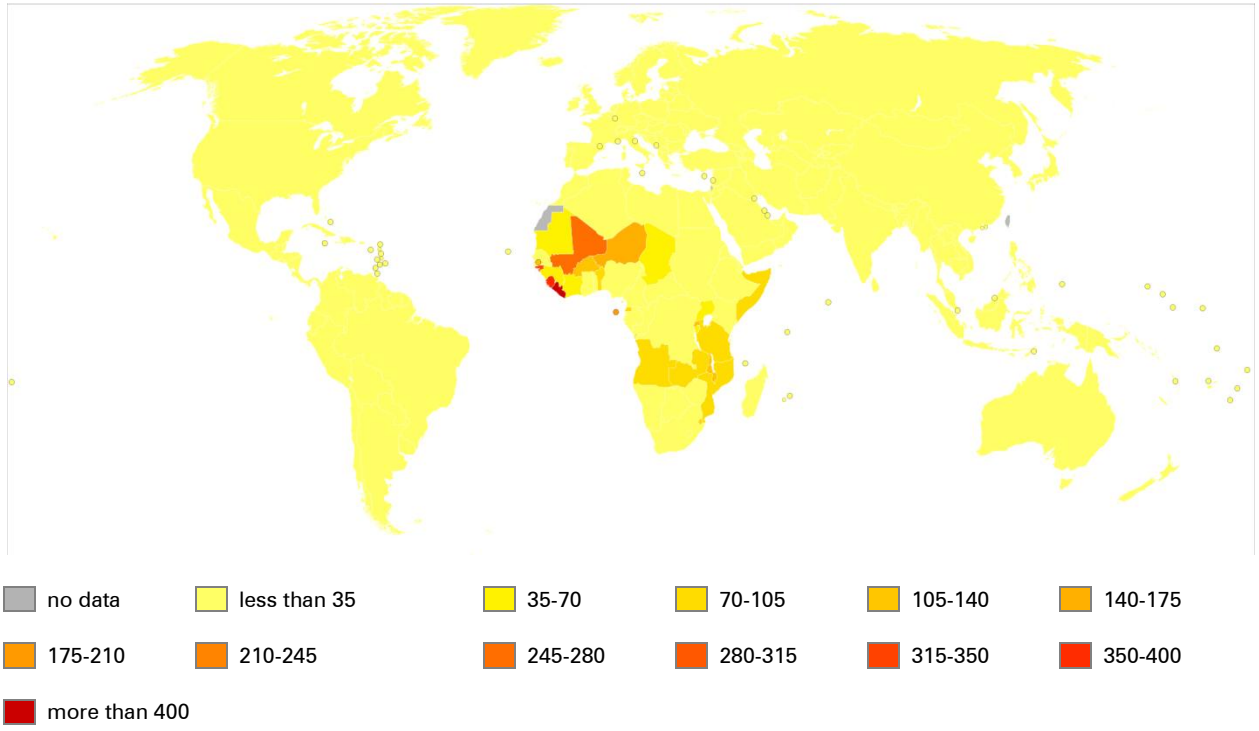
Source: *Mortality and Burden of Disease estimates for WHO member states in 2002*



Annexure – 6: *(Vitamin – A Deficiency)*

Age-standardised disability-adjusted life year (DALY) rates from Vitamin A deficiency by country (per 100,000 inhabitants)

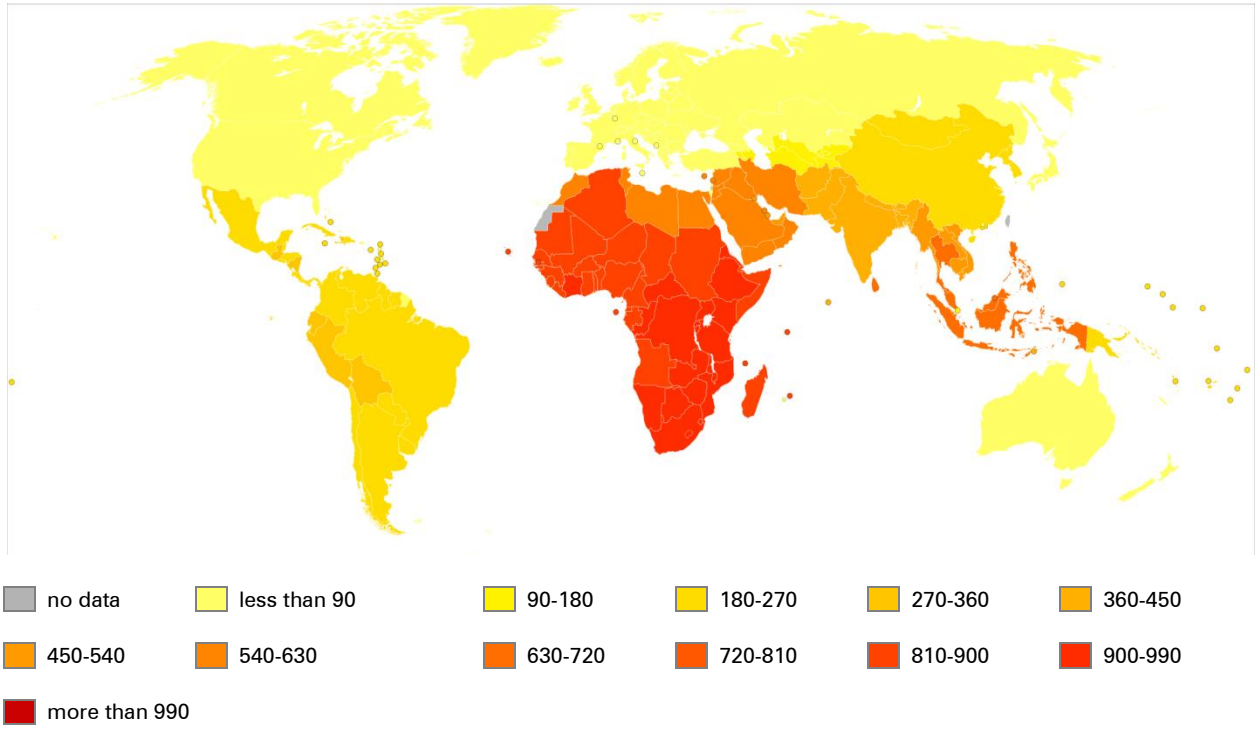
Source: *Mortality and Burden of Disease estimates for WHO member states in 2002*



Annexure – 7: *(Cataract)*

Age-standardised disability-adjusted life year (DALY) rates from Cataracts by country (per 100,000 inhabitants)

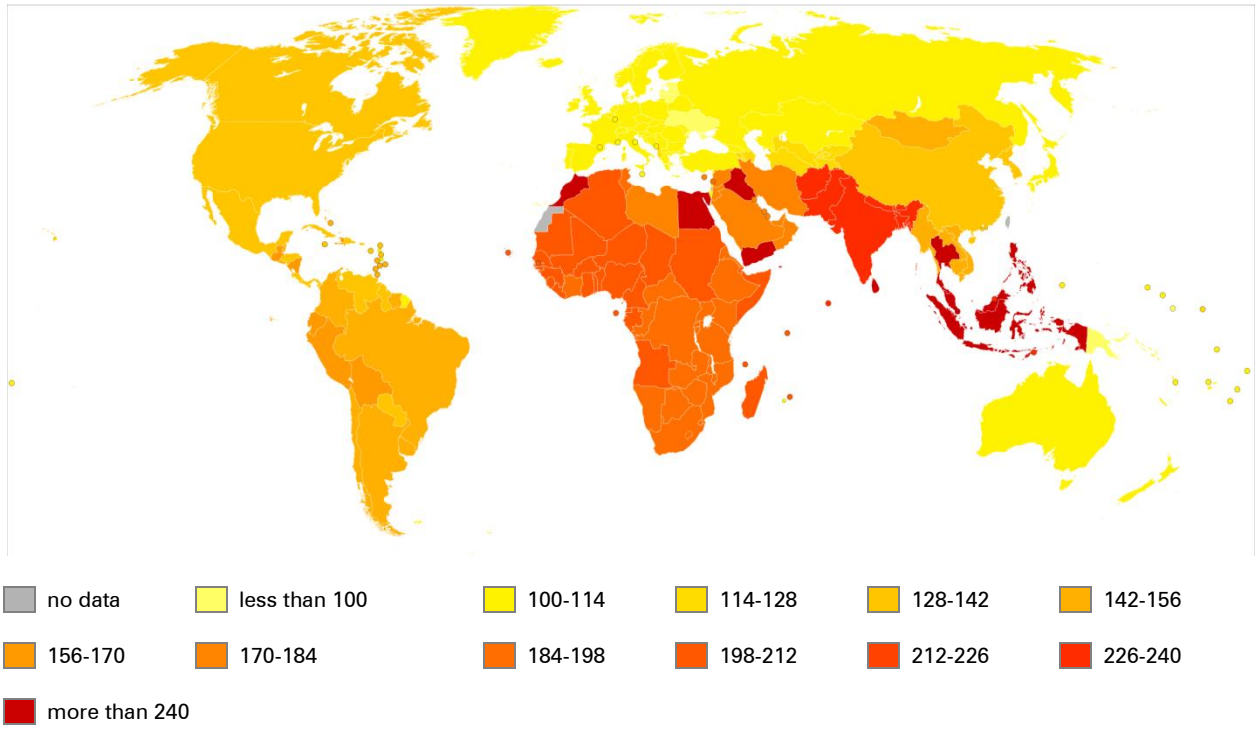
Source: *Death and DALY estimates for 2004 by cause for WHO Member States (Persons, all ages)*



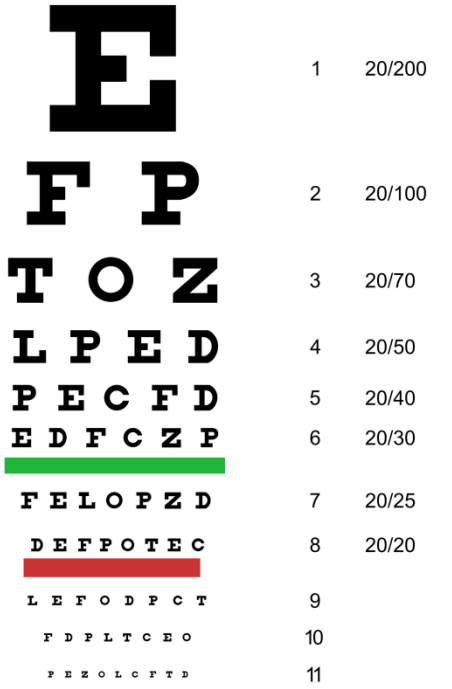
Annexure 8: *(AMD – Age related Macular Degeneration)*

Age-standardised disability-adjusted life year (DALY) rates from Macular degeneration and other (sense organ diseases) by country (per 100,000 inhabitants). Note from WHO data: "*Includes macular degeneration and other age-related causes of vision loss not correctable by provision of glasses or contact lenses, together with deaths due to other sense organ disorders.*" Excludes: Glaucoma, Cataracts, Refractive errors and Hearing loss (adult onset)

Source: *Death and DALY estimates for 2004 by cause for WHO Member States (Persons, all ages)*



Annexure 9: *(Snellen Chart)*



(a)

(b)

A Snellen chart (a) is an eye chart used by eye care professionals and others to measure visual acuity. The traditional Snellen chart is printed with eleven lines of block letters. The first line consists of one very large letter, which may be one of several letters, for example E, H, or N. Subsequent rows have increasing numbers of letters that decrease in size. A person taking the test covers one eye, and reads aloud the letters of each row, beginning at the top. The smallest row that can be read accurately indicates the visual acuity in that eye. Outside of the US, the standard chart distance is six meters, normal acuity is designated 6/6, and other acuities are expressed as ratios with a numerator of 6. Acuity charts are used during many kinds of vision examinations, such as "refracting" the eye to determine the best eyeglass prescription. During such examinations, acuity ratios are never mentioned. The largest letter on an eye chart often represents an acuity of 20/200 (6/60), the value that is considered "legally blind." Some individuals with moderate myopia may not be able to read the large E without glasses, but have no problem reading the 20/20 line or 20/15 line with glasses. By contrast, legally blind individuals have a visual acuity of 20/200 (6/60) or less when using the best corrective lens.

An **E Chart,** also known as a **Tumbling E Chart,** is an ophthalmological chart used to measure a patient's acuity for distant vision. This chart is useful for patients that are illiterate or too young to read but who can speak. A **Landolt C** (b), also known as a **Landolt ring** or **Landolt broken ring**, is an optotype, i.e. a standardized symbol used for testing vision.

Annexure 10: *(Trial Lens Set + Trial Frame & Phoropter)*

(a)

(b)

A trial lens set (a) along with a trial frame (b) is used in conjunction with a Snellen chart to arrive at the appropriate corrective lens prescription for the patient.

A **phoropter** is the device commonly used, in conjunction with a Snellen chart, to determine the best corrective lenses for a person being assessed for eyeglasses or contact lenses. The phoropter contains a complete range of corrective lenses, allowing the person to compare different levels of correction while viewing the chart. Typically, the eye doctor will use the phoropter to refine the information obtained from the autorefractor before prescribing lenses.

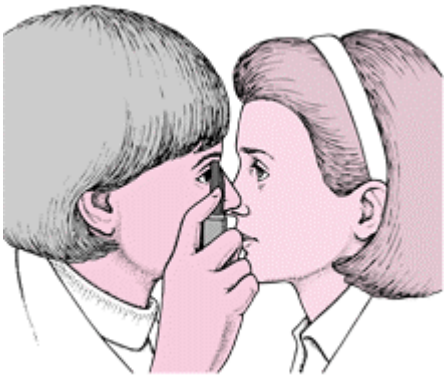
Annexure 11: *(Streak Retinoscope)*

Streak Retinoscope is an Ophthalmic Instrument which is used to objectively determine the refractive error of an eye.

Annexure 12: *(Direct Opthamascope)*

(a)

(b)



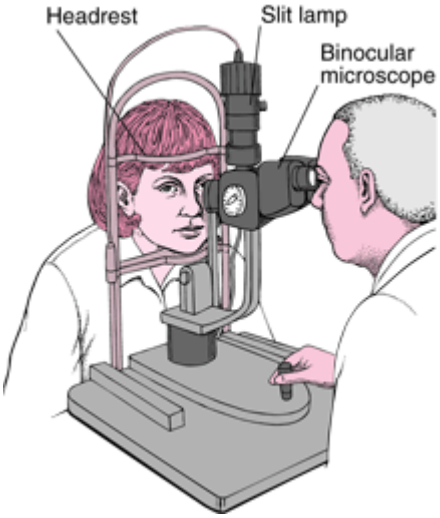
(c)

A direct ophthalmoscope (a&b) is a handheld device like a small flashlight with magnifying lenses that shines a light into the eye to enable a doctor to examine the cornea, lens, vitreous humor, retina, optic nerve, and the retinal veins and arteries. The person looks straight ahead as the beam of light is shone into the eye. Often, eye drops are given to dilate (enlarge) the pupil, which allows the doctor to have a better view. Ophthalmoscopy is painless, but if eye drops are used to dilate the pupils, vision may be temporarily blurred, and the person will be more sensitive to light for a few hours afterward.

Ophthalmoscopy (c) is a standard part of every regular eye examination. Ophthalmoscopy is used to detect not only changes in the retina due to eye disease but also changes in the eyes due to certain diseases affecting other parts of the body. For instance, it is used to detect the changes that occur in the retinal blood vessels in people who have high blood pressure, arteriosclerosis, and diabetes mellitus. Ophthalmoscopy may also provide a clue to elevated pressure within the brain, which results in a swelling (pushing-out) of the normally cupped optic disk (papilledema). Tumors on the retina can be seen with ophthalmoscopy. Macular degeneration can be diagnosed with ophthalmoscopy as well.

Source: http://www.merckmanuals.com/home/sec20/ch225/ch225c.html

Annexure 13: *(Slit Eye Lamp)*



(a)

(b)

The slit lamp is a table-mounted binocular microscope (a&b) that shines a light into the eye to allow the doctor to examine the entire eye under high magnification. The slit lamp has better optics than the direct ophthalmoscope, providing magnification and a three-dimensional view, which allows measurement of depth. Often, eye drops are used to dilate the pupils so that the doctor can view even more of the eye, including the lens, vitreous humor, retina, and optic nerve. Sometimes, in people who have or might have glaucoma, an additional lens is placed on or held in front of the eye to allow examination of the "angle" between the iris and the front part of the eye (inside surface of the cornea). This examination is called gonioscopy.

Source: http://www.merckmanuals.com/home/sec20/ch225/ch225c.html

Annexure 14: *(Tonometer)*

Tonometry is the measurement of tension or pressure. A **tonometer** is an instrument for measuring tension or pressure. In ophthalmology, tonometry is the procedure eye care professionals perform to determine the intraocular pressure (IOP), the fluid pressure inside the eye. It is an important test in the evaluation of patients with glaucoma. Most tonometers are calibrated to measure pressure in millimeters of mercury (mmHg).

Annexure 15: *(Eye Care Professionals)*

- **An Ophthalmologist** refers to a specialist in medical and surgical eye problems. Since ophthalmologists perform operations on eyes, they are considered to be both surgical and medical specialists. Ophthalmology is the branch of medicine which deals with the anatomy, physiology and diseases of the eye.

- **An Optometrist** is a health care profession concerned with eyes and related structures, as well as vision, visual systems, and vision information processing in humans. Optometrists are qualified to diagnose and treat eye diseases such as infections and glaucoma. They also advise customers on aesthetics.

- **An Optician** is a trained professional to fill prescriptions for eye correction in the field of medicine, also known as a dispensing optician or optician, dispensing.

Annexure -16: *(Surveyed Price (Indian Rupees) – Trial Lens Set and Trial Frame, Streak Retinoscope, Ophthalmoscope)*

Product	Price (Indian Rupees)
Trial Lens Set and Trial Frame	
Deepak Optics (Phone: 044-25393800)	
Trail Lens Set (Lighting)	8,500
Trial Lens Set (Medium)	1,200
Trial Lens Set (Small)	1,000
Trail frame	40
Suraj-Hi-Tech (Phone: 044 24751055) info@surajhitech.com	
Regular Trial Set with Trial Frame	7,500
Baliwala Trial Set with Medik Trial Frame -	14,500
Medik Type Trial Frame	500

Product	Price (Indian Rupees)
Streak Retinoscope	
Appaswamy (Phone: 044 32932406) info@appasamy.com	
AA17- Streak Retinoscope	6,500
Suraj-Hi-Tech (Phone: 044 24751055) info@surajhitech.com	
Streak Retinoscope Xenon Bulb 3.5V Rechargeable Battery Set (Riester)	12,500
Garuda Med Equipments (Phone 9884830003) sathishm@welchallyn.com	
3.5v-Streak Retinoscope with set c/w 71055 with case (WelchAllyn)	12,590

Product	Price (Indian Rupees)
Opthalmoscope	
Garuda Med Equipments (Phone 9884830003) sathishm@welchallyn.com	
3.5v-Coaxial Opthalmoscope (WelchAllyn)	11,680
Pocket Opthalmoscope (WelchAllyn)	5,650
3.5v-11710 Opthalset-with case, C-cellbatter dignostics (WelchAllyn)	11,530
Pan-optic Opthalmoscope with Blue filter and Lens (WelchAllyn)	29,640
Binocular Indirect Opthalmoscope 12500D-without transformer (WelchAllyn)	53,200
Suraj-Hi-Tech (Phone: 044 24751055) info@surajhitech.com	
Ophthalmoscope with Xenon Bulb (3.5v) & Li-Ion Rechargeable Battery Set (Riester)	10,700