



# REFRACTIVE ERROR

**Keerti Bhusan Pradhan**



# Overview

- ⌘ Magnitude
- ⌘ Challenges
- ⌘ Trends



## Blindness and Visual Impairment & Refractive Error: WHO Definitions

### FROM EYE DISEASE

⌘ **37 million blind** with less than 3/60 in the better eye

⌘ **124 million** have treatable or untreatable low vision

*A Total of 161 million people*

### FROM REFRACTIVE ERROR

⌘ **153 million** people – including 5 million blind from RE

⌘ A further **39 million children** with vision less than 6/12 in the better eye

⌘ A further **150 million (at least)** who have significant near visual impairment due to presbyopia

*Over 300 million people*

# Refractive Errors

**25% myopic (1.6 billion)**

**24% presbyopic (1.5 billion)**

**11% other**

(significant hyperopia, astigmatism, etc)

=

**60% of the World's population**

=

**3.8 billion people**

WORLD SIGHT DAY 12 OCT 06

WORLD SIGHT DAY 12 OCT 06



LOW VISION & REFRACTIVE ERROR



LOW VISION & REFRACTIVE ERROR



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**Helping people SEE better**

Low vision & refractive services change people's lives.  
Join us in marking World Sight Day.  
Find out how at [www.v2020.org](http://www.v2020.org).

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**World Health  
Organization**

## **Sight test and glasses could dramatically improve the lives of 150 million people with poor vision WHO releases new global estimates to mark World Sight Day**

11 OCTOBER 2006 | GENEVA -- A simple sight test and eyeglasses or contact lenses could make a dramatic difference to the lives of more than 150 million people who are suffering from poor vision. Children fail at school, adults are unable to work and families are pushed into poverty as a result of uncorrected visual impairment.

To mark World Sight Day, 12 October 2006, the World Health Organization (WHO) has released new global estimates which, for the first time, reveal that 153 million people around the world have uncorrected refractive errors (more commonly known as near-sightedness, far-sightedness and astigmatism). Refractive errors can be easily diagnosed, measured and corrected with eyeglasses or contact lenses, yet millions of people in low and middle income countries do not have access to these basic services.

Without appropriate optical correction, millions of children are losing educational opportunities and adults are excluded from productive working lives, with severe economic and social consequences. Individuals and families are frequently pushed into a cycle of deepening poverty because of their inability to see well. At least 13 million children (age 5 to 15) and 45 million working-age adults (age 16 to 49) are affected globally. Fully 90% of all people with uncorrected refractive errors live in low and middle income countries.

"These results reveal the enormity of the problem," said Dr Catherine Le Gales-Camus, WHO Assistant Director-General, Noncommunicable Diseases and Mental Health. "This common form of visual impairment can no longer be ignored as a target for urgent action."

WHO previously estimated that 161 million people were visually impaired from eye diseases such as cataract, glaucoma and macular degeneration. Uncorrected refractive errors were not included in these earlier estimates. These latest WHO estimates add to the previous number and effectively double the estimated total number of visually-impaired people worldwide, bringing it to some 314 million people globally. The estimates also confirm that uncorrected refractive errors are a leading cause of visual impairment worldwide.

As part of the VISION 2020 Global Initiative to eliminate avoidable visual impairment and blindness worldwide, WHO has been working with its partners to improve access to affordable eye exams and eyeglasses for people in low and middle income countries. This new information concerning the prevalence of refractive errors will strengthen the efforts of the VISION 2020 partnership to raise awareness of the magnitude of the problem and spur increased commitment for action.

"Correction of refractive errors is a simple and cost-effective intervention in eye care," said Dr Serge Resnikoff, Coordinator of WHO's Chronic Disease Prevention and Management unit. "Now that we know the extent of the problem of uncorrected refractive errors, especially in low and middle income countries, we must re-double our efforts to ensure that every person who needs help is able to receive it."

### **NOTE TO EDITORS**

Refractive errors occur when the eye is not able to correctly focus images on the retina. The result is blurred vision, which is sometimes so severe that it creates functional blindness for affected individuals.

The three most common refractive errors are:



# WHO Press Release....

⌘ “To mark World Sight Day, 12 October 2006, the World Health Organization (WHO) has released new global estimates which, for the first time, reveal that

**153 million people around the world have uncorrected refractive errors** (more commonly known as near-sightedness, far-sightedness and astigmatism)”.

⌘ “Refractive errors can be **easily diagnosed**, measured and **corrected with eyeglasses** or contact lenses, yet millions of people in low and middle income countries do not have access to these basic services”.

# Prevalence of Refractive Error in Children (<math><0.5D</math> to <math>>+2.00D</math>)

*\* RESC Studies, Ellwein et al, 2000, 2002*

**USA**  
(Inner City Children, HKW)  
**37%**  
**67% Uncorrected**

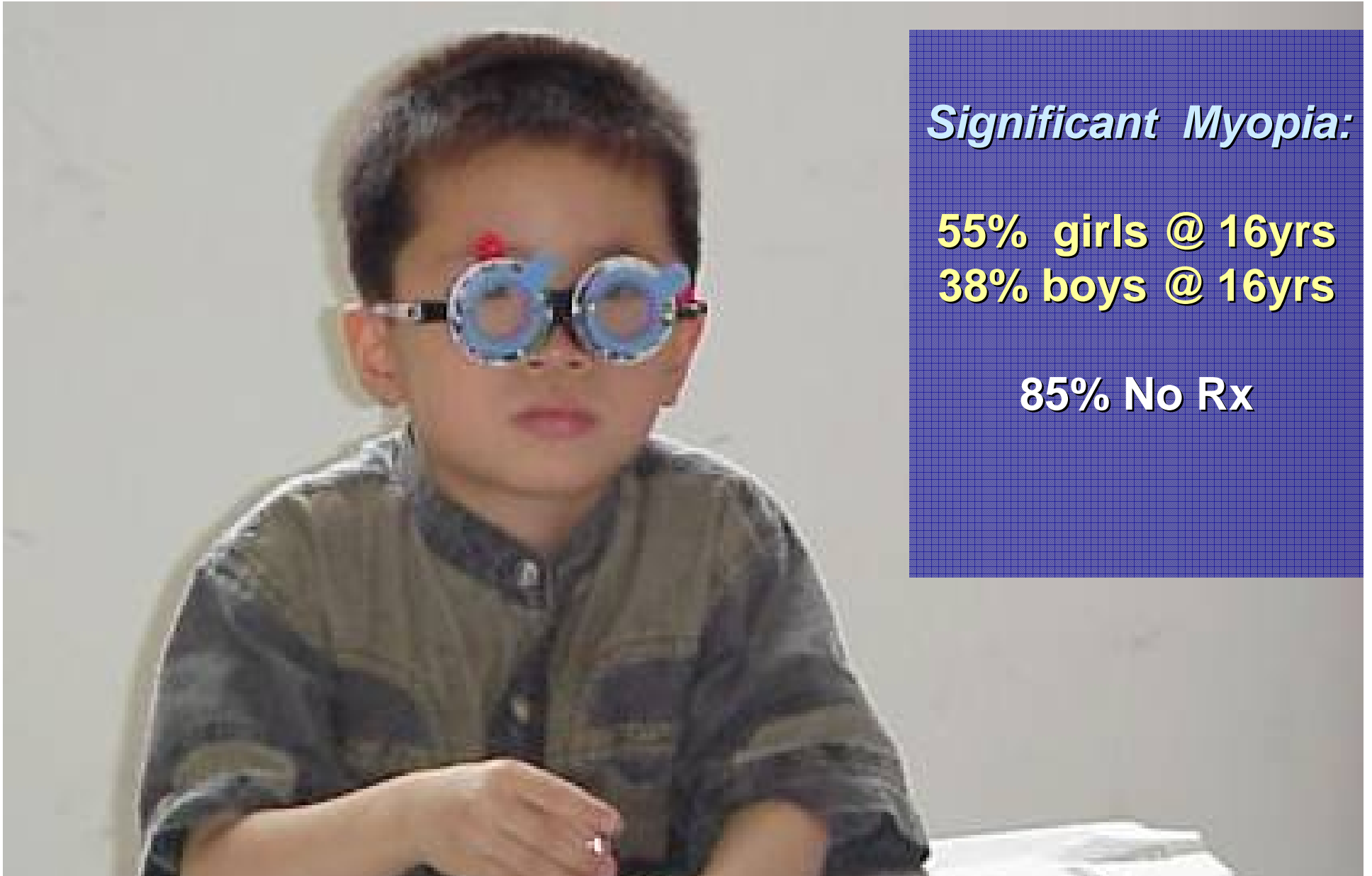
**China\***  
**41%**  
**85% Uncorrected**

**Chile\***  
**15%**  
**56% Uncorrected**

**India and Nepal\***  
**3%**  
**88% Uncorrected**

**RE: 56% to 88% Uncorrected**





***Significant Myopia:***

**55% girls @ 16yrs**

**38% boys @ 16yrs**

**85% No Rx**

**Refractive Error Study in Children: Results from Shunyi District, China,**  
*Jialiang Zhao, Xiangjun Pan, Ruifang Sui, Sergio Munoz, Robert Sperduto, Leon Ellwein. Am J, Ophthal, April, 2000, 427 - 435*

# Service Delivery Gap for Africa

In Africa it is estimated that between 1% and 35% of people are getting the vision care they need



# Impact of uncorrected refractive error

WHO Press Release....

⌘ 11 OCTOBER 2006 GENEVA –

“A simple sight test and eyeglasses or contact lenses could make a dramatic difference to the lives of more than 150 million people who are suffering from poor vision. ***Children fail at school, adults are unable to work and families are pushed into poverty as a result of uncorrected visual impairment.***”

⌘ ***Severe economic and social consequences***



# Barriers

- ⌘ Access
- ⌘ Affordability
- ⌘ Lack of trained eye care personnel
- ⌘ Lack of awareness
- ⌘ Cultural barriers



# Refractive Error Issues in Latin America



# Latin America Issues

- ⌘ All countries in the region have at least ophthalmologists and opticians (unique exception Trinidad & Tobago)
- ⌘ Only 37% of the countries have optometry as a profession at different academic levels.
- ⌘ Even in all the countries where optometry exists as a profession, local authorities sometimes do not give it recognition.

# LA-Statistics

Country	N° Optometrists	N° Opticians	N° Ophthalmologists	Population (millions)
Argentina	No recognition	2000	3400	40'
Bolivia	Do not exist	180	120	10'
Brazil	No recognition	3500	11350	188'
Colombia	3700	-	1200	47'
Ecuador	565	215	340	17'
Perú	650	250	850	28'
Uruguay	Do not exist	380	250	3.5'

# Refractive errors in Africa

## The Main challenges

- ⌘ Data on Refractive Errors still very limited
- ⌘ Human Resources largely inadequate and opportunities and places to train more remain limited
- ⌘ Infrastructure to support and sustain refractive service still in its infancy in many countries and still poorly distributed
- ⌘ Access to technology and spectacles remain limited, especially to the poor and needy.





## Comparing the Cost Effectiveness of SES vs. PEC model to provide refractive error services in India

This study talks about School Eye Screening is more cost effective than Primary Eye Care model.

SES:

The cost to examine a child: \$0.64

The cost to examine a child and dispense a spectacle:  
\$12.13

PEC:

The cost to examine a child: \$3.10

The cost to examine a child and dispense a spectacle:  
\$25.58

For the details of this study please contact:  
[lester\\_bj@hotmail.com](mailto:lester_bj@hotmail.com) Barry A Lester

This study is done in India and a very recent study.

# South Africa - National Refractive Error Program


## The Challenge

- ⌘ South Africa is in the unique position of technically having **enough optometrists** to meet the needs of the population; however there are enormous **inequities** in the provision of health care services throughout the country.
- ⌘ The Department of Health estimates that **85 percent of the population relies on public health care**, yet **only 2% of optometrists are employed in the public sector** - effectively leaving 25 optometrists to meet the needs of 38 million people.

# South Africa

- ⌘ Estimates are that at least 10 percent of those South Africans ages 15 to 42 have some refractive error, with the elderly, women and children disproportionately affected.
- ⌘ A recent Refractive Error Study in school going children, 5 to 15 years of age, revealed that of those children requiring glasses, only 20 percent had them. The remaining 80 percent will struggle with learning and have reduced opportunities for the future as a result of poor vision.
- ⌘ In addition, data indicates that women in South Africa bear a much higher burden of blindness - up to 40 percent higher - often due to cultural and economic reasons.

# Key Challenges in dealing with refractive error

- ⌘ Lack of Data for planning
  - ⌘ Poor Practitioner to Patient Ratio
  - ⌘ Uneven distribution of personnel
  - ⌘ Poorly Trained Personnel
  - ⌘ Availability of Equipment
  - ⌘ Availability of Spectacles
  - ⌘ Funding
- 

# Key Challenges in dealing with refractive error

⌘ Data

⌘ Human resources

⌘ Infrastructure

⌘ Financing



# Difficulties with Current Data

- ⌘ Lack of evidence about availability of RE services in the community versus base hospital
- ⌘ Non-uniform definitions across studies
- ⌘ Non-representative study populations (convenience rather than population-based)
- ⌘ Dissimilar demographics of study population (age and sex)
- ⌘ Different Refraction procedures used in different studies (with/without cycloplegia etc)

# Human resources

## ⌘ Inadequate HR for screening

- High inadequacy at the community level

## ⌘ Training more optometrists/refractionists urgently needed

## ⌘ Inadequate and differing standards of certification



# INFRASTRUCTURE

## ⌘ Vision Centres

- Eye care clinics, stand alone or in Community Health Centre

## ⌘ “Optishop”

- Optical workshop & dispensing unit

## ⌘ Optometry/Refractionist training

## ⌘ Outcomes research

# **COST to Correct URE (spectacles)**

**300 million PEOPLE**

**@**

**US\$3 per person**

**=**

**\$1 billion (Approx.)**

**(\$1 billion set up and running costs for first 3  
years and then Self-sustaining)**

# The Cost of Not Doing It.....

## **Australia: Access Economics (CERA and Vision CRC, 2005)**

- ⌘ The Cost of Vision Disorders is  
A\$9.85 billion per year .....  
(\$500 per person in direct and indirect costs)

## **Frick and Foster, April 2003:**

- ⌘ *“US\$102 billion can be saved, and 100 million people prevented from going blind, over the next 20 years through the successful implementation ..... VISION 2020: The Right to Sight”*

# The ICEE Solution

Trained Eyecare Personnel

+

Affordable Glasses

= People Who Can See

- Identify regional need
- Develop relationships with existing NGOs and ECPs
- Develop a model for eyecare services with local **community participation**
- Review and improve the model with local input



# SOUTH AFRICA –CASE STUDY

From Outreach to Sustainability



# Optometry team

## **Optometrist**

Trial case

Ophthalmoscope and retinoscope

Autorefractor (from 2002)

## **Admin/Dispensing assistant**

Paperwork

Manage readymade stock

Assist with frame selection

## **Volunteers**

# Optometry service

## ⌘ Minimal pre-screening of patients

- Twin objectives
  - Screen for pathology
  - Refract and prescribe
- ALL patients where screened before eye examinations where conducted
  - Very rudimentary screening to identify patients with mature cataracts etc needing referral

# Spectacle Provision

## ⌘ Ready makes

- Least cost
- Immediately available
- Mainly readers



## Made to order

Cost more  
Single vision and bifocal  
Tints optional





# Challenges

## ⌘ Weather dependant

- No flights in bad weather

## ⌘ Language barrier

- Translators required

## ⌘ Physical space

- Most hospitals were formerly Mission Hospitals
- Hospitals had limited space
- Improved as hospital infrastructure was upgraded

## ⌘ Huge Demand

- Limited time per patient

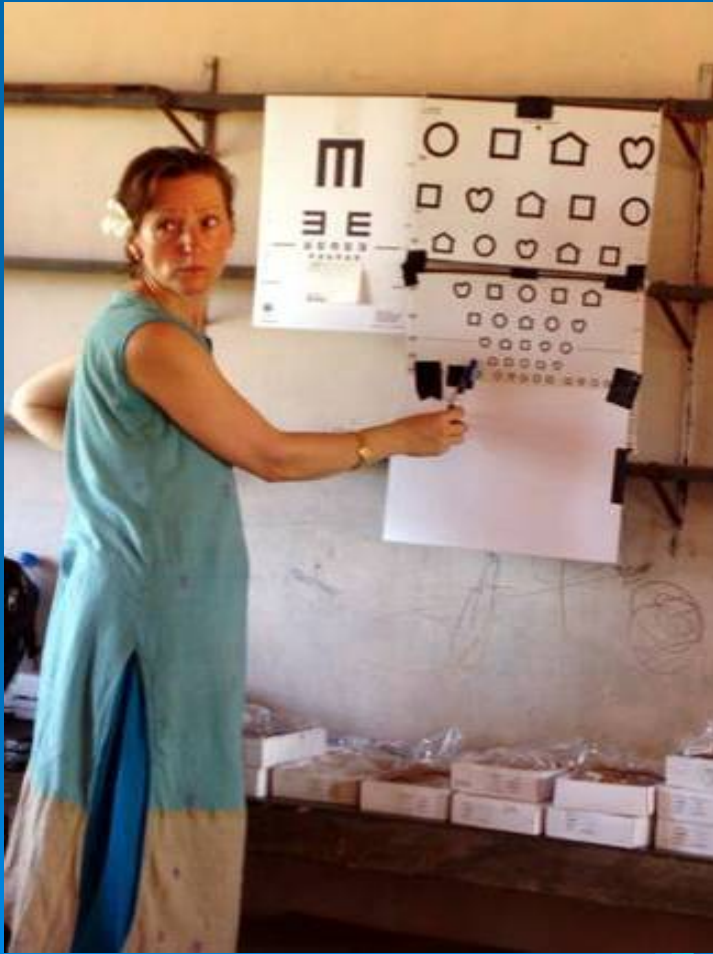


# What do we need to do

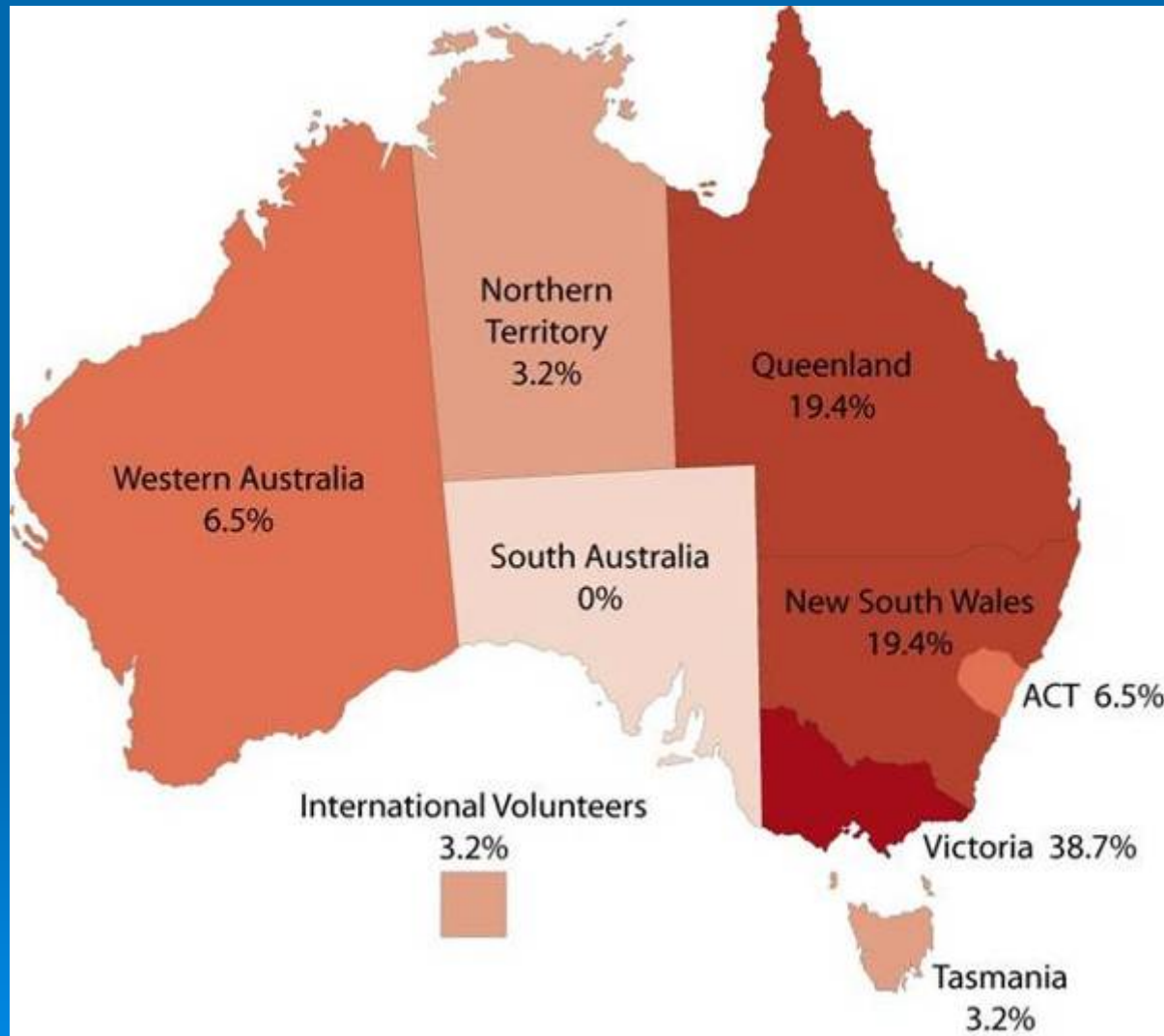
- ⇒ Countries should move away from disjointed RE activities
- ⇒ More urgently needed: coherent and effective "system" to deliver refractive services to the community at large.
- ⇒ **Such a system could include:**
  - policies for training, recruitment and deployment of staff throughout the country
  - a sustainable system for the procurement and distribution of affordable spectacles
  - targeting high priority groups, e.g., school children, "professional presbyopes (nurses, teachers, industry workers etc)

# SRILANKA MODEL OF REFRACTIVE ERROR SERVICES THROUGH VOLUNTEERS





# Personal Demographics



Where did our  
volunteers  
come from?



# HELPING PEOPLE TO IMPROVE QUALITY OF LIFE



# GLOBAL INITIATIVE REALLY A NEED



La Oroya 2000



La Campiña 2001



Ayacucho 2001



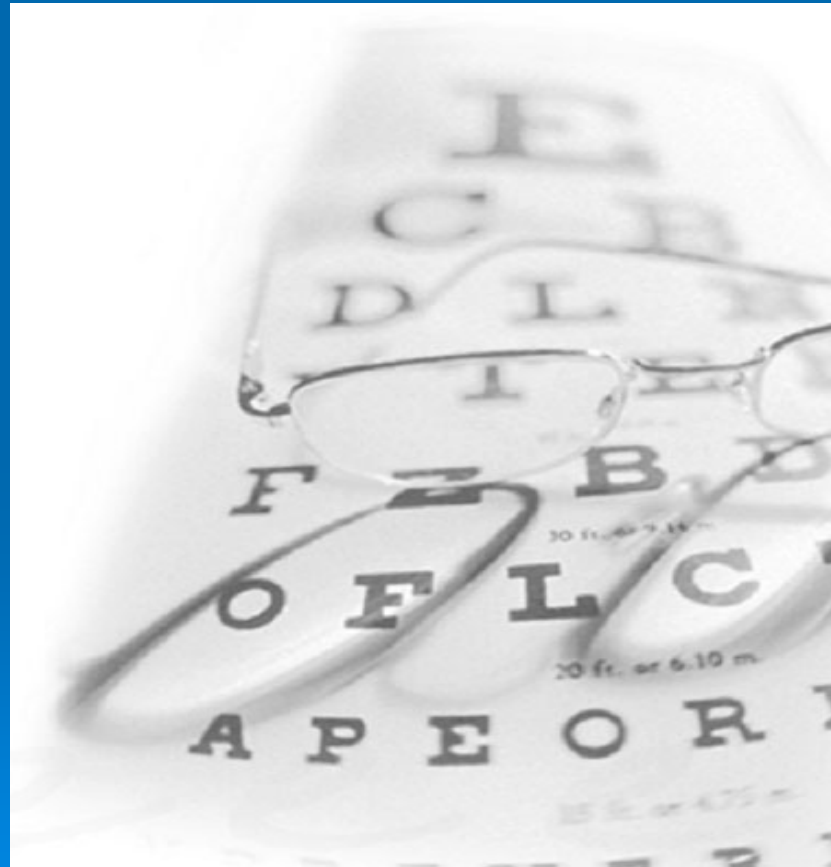
Nazca 2004

*Thank You*

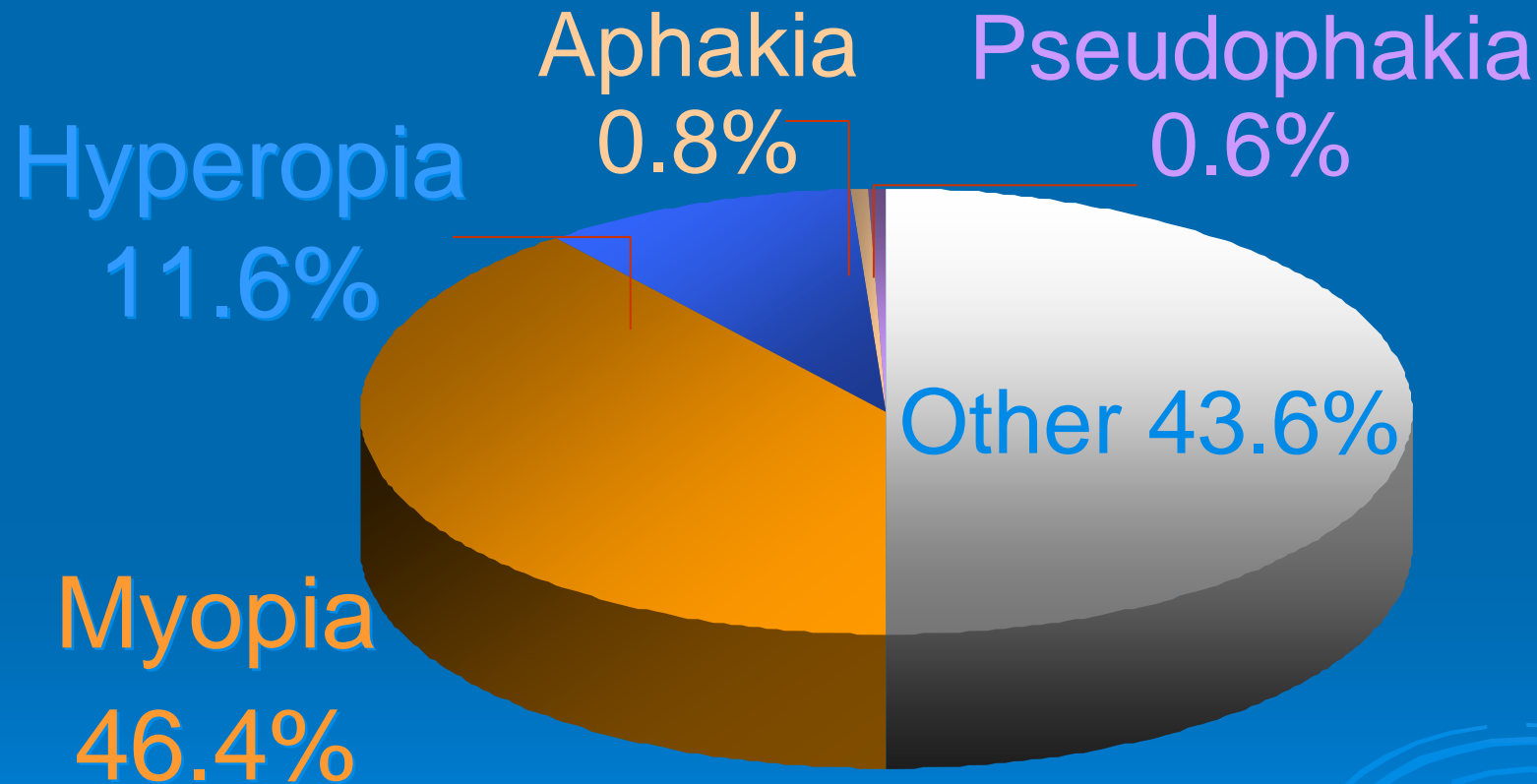




# What can be done



# INDIA: Causes of Impaired Vision (6/18 or less)



**Refractive Error - 56.4%**

# Sri Lanka

**33,107 people seen**

⌘ *86% needed refractive error correction*

**28,103 glasses dispensed**

⌘ *75% had never had an eye exam before*

⌘ *17% needed high Rx*

**6% referrals**



# PAKISTAN-Results: refractive errors as a cause of visual loss

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## ⌘ Blindness prevalence (<3/60 p. VA better eye):

- Prevalence = 3.4% (3.1-3.7%)

## ⌘ Blindness causes:

- Cataract = 51.5%
- Refractive errors = 2.7% (30,780)

## ⌘ Mild + severe visual impairment prevalence (<6/18 – 3/60 p. VA better eye):

- Prevalence = 14.3% (13.8 to 14.9%)

## ⌘ Mild + severe visual impairment causes:

- Refractive errors = 39% (2,141,000)

**TOTAL VI due to refractive errors = >2,000,000**

# Magnitude by Province

## (from age/sex standardised prevalence)

Province	Myopia (all)	Hypermet. (all)	Total
Punjab	9,310,000	7,370,000	16,680,000
Sindh	3,415,000	2,045,000	5,460,000
NWFP	1,670,000	1,380,000	3,050,000
Balochistan	530,000	630,000	1,160,000
<b>Total:</b>	<b>14,925,000</b>	<b>11,425,000</b>	<b>26,350,000</b>

⌘ Myopia\* (more than -0.5D) Total = 8,150,000

⌘ Myopia\* (more than -5.0D) Total = 1,000,000

\* after excluding those with significant lens opacities: 5,775,000

# Overview of Studies

Author / Year	Country	Sample size	Study population	Definition	Prevalence of RE(%)
Wong 2000	Singapore	1232	Adult Chinese in Singapore aged 40 - 79 years	$\geq 0.50$ D	Myopia 38.7
Wu 2001	Singapore	15095	Military conscripts 16 - 25 years	$\geq 0.50$ D	Chinese 82.3 Indians 68.7 Malays 65.0
Saw SM 2005	Malaysia	1792	7 - 9 yr old Malay, Chinese, Indian	Myopia SE $\geq 0.50$	Malays - 22.1 Chinese - 30.9 Indians - 12.5
	Singapore	1962	7 - 9 yr old Malay, Chinese, Indian	Myopia SE $\geq 0.50$	Malays - 47.7 Chinese - 38.4 Indians - 34.0
Author / Year	Country	Sample size	Study population	Definition	Prevalence of RE(%)
Woo 2004	Singapore	157	Second year medical students (19-23 yrs of age)	Myopia SE $\geq 0.50$ Hyperopia SE $\geq 0.50$	Myopia - 89.8 Hyperopia - 1.3 Astigmatism 82.2
Quek 2004	Singapore	946	Grade 9 & 10 students (15-19 yrs of age)	Myopia SE $\geq 0.50$ Hyperopia SE $\geq 0.50$	Myopia 73.9 Hyperopia 1.5 Astigmatism 58.7
Saw SM 2002	Riau Province, Sumatra, Indonesia	1043	21 yrs and older	Myopia SE $\geq 1.0$ Hyperopia SE $\geq 1.0$ Astigmatism $\geq 1.0$	Myopia 26.1 Hyperopia 18.5 Astigmatism 15.1

# Bangladesh

- ⌘ A nationally representative sample of 12 782 adults 30 years of age and older
- ⌘ 6412 (57.3%) were emmetropic
- ⌘ 2469 (22.1%) were myopic ( $<-0.5$  D)
- ⌘ 2308 (20.6%) were hypermetropic ( $>+0.5$  D).
- ⌘ 216 subjects (1.8%) were high myopic ( $<-5$  D)

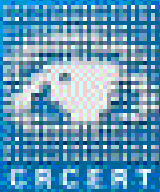
# Singapore

- ⌘ Adult Chinese population in Singapore, aged 40 to 79 years
- ⌘ Prevalence of myopia - 38.7%
- ⌘ Hyperopia - 28.4%
- ⌘ Astigmatism - 37.8%
- ⌘ Anisometropia - 15.9%
- ⌘ Prevalence of high myopia was 9.1%



# Indonesia

- ⌘ Prevalence survey of 1043 adults  $\geq 21$  years of age was conducted in five rural villages and one provincial town of the Riau Province, Sumatra, Indonesia.
- ⌘ Prevalence of myopia (SE  $\geq -1.0$  D) - 26.1%
- ⌘ Hyperopia (SE  $\geq +1.0$  D) - 18.5%
- ⌘ Astigmatism ( $\geq -1.0$  Dcyl) - 15.1%



# AUSTRALIA

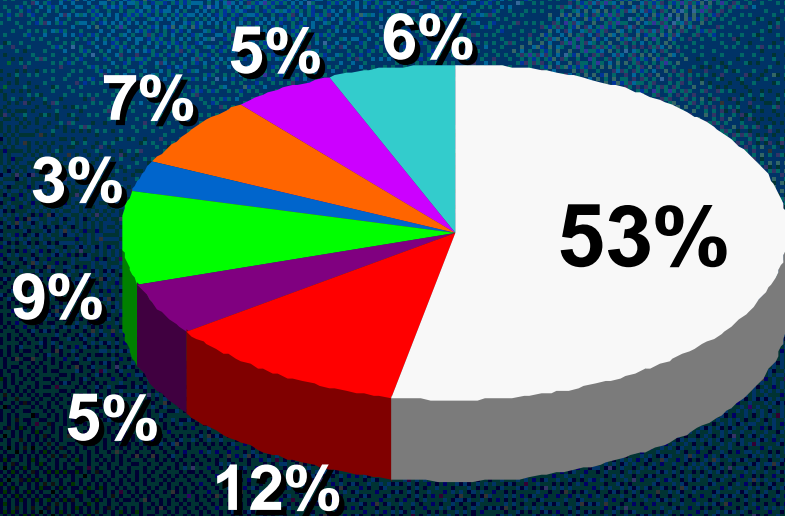
Prof Hugh Taylor, et al

## Less than Driving Vision ( $6 < 12$ )

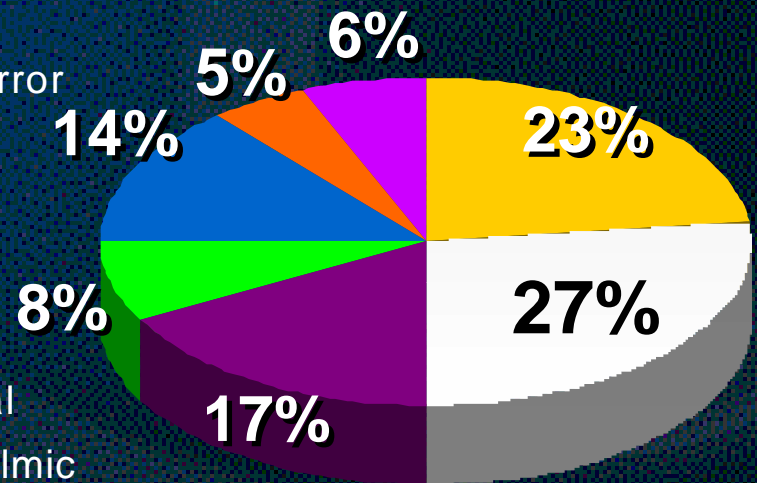
Total 340,500

## Legal Blindness ( $< 6/60$ )

Total 52,800



- Refractive Error
- AMD
- Glaucoma
- Cataract
- Diabetes
- Other Retinal
- Neuro-ophthalmic
- Others



ICEE