WORLD VIEW

Vision impairment in the Pacific region

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The Western Pacific region is one of great diversity, containing the most populous country, China, and many small Pacific island countries. This review describes the prevalence of blindness and vision loss, illustrates the changing trends in the important causes of vision loss and blindness, and the stages of development of the delivery of eye care services across this region.

The World Health Organization (WHO) and the International Agency for the Prevention of Blindness (IAPB) designated Western Pacific region as one of great diversity. It contains the most populous country, China with its 1.2 billion people, and many small Pacific island countries, some with populations of less 10 000. The diversity also extends to politics, sociocultural life, and the economies of the countries. The region is made up of the land mass of China and Mongolia, the Korean peninsula, Japan, Indochina (Vietnam, Laos, and Cambodia), ASEAN countries (Philippines, Singapore, Malaysia, and Brunei Darussalam), the continental land mass of Australia, New Zealand, and the island nations grouped as Melanesian, Micronesian and Polynesian (Table 1). The diversity is also seen in the availability and provision of eye care to the people of the region.

PREVALENCE

Definitions

One of the great difficulties in compiling data on the prevalence of vision loss and blindness across a region has been the use of different definitions of low vision and particularly of blindness. The WHO has encouraged the use of standard visual acuity criteria to be used in surveys to estimate the prevalence and incidence of vision impairment. The levels for categorisation as low vision is visual acuity <6/18 and blindness is indicated by visual acuity <3/60.[1]

Prevalence and rate of vision loss

In order to gain insight into the magnitude of vision impairment (blindness and low vision) within a population, the rate has been calculated as the number of people with impaired vision per million people. Using this approach one gains an appreciation of the national and regional burden in actual numbers of people needing eye care. The number of people with vision impairment in each country can then be multiplied by the number (or fraction) of millions of people (Table 1).

Where population surveys have been undertaken and reported in the literature, the source of data in Table 1 is indicated by "S." For some countries, there have been no surveys but estimates (E) have been made on both the prevalence and causes of impaired vision. The figures for Singapore are based on a register (R).

For countries where there are no prevalence data it is possible to make estimates using these geopolitical groupings. For example, a small country such as Brunei Darussalam could utilise data from the Malaysian survey. In that survey data on prevalence and causes were reported for each of the Malaysian states which makes a reasonable estimate feasible.[2] Similarly, there are no data from the small Micronesian countries and some neighbouring Melanesian countries. In this region the major eye diseases causing vision loss are cataract and diabetic retinopathy. With knowledge of the increasing problem of diabetes and lack of cataract services, eye care planning could proceed without the need for a survey to determine the current situation regarding prevalence and causes of vision loss.

Low vision

The prevalence of low vision is often not included in surveys of vision impairment. The inclusion of the number of people with moderate or severe impairment of vision (low vision) is necessary to appreciate the extent of the burden of vision impairment. It also provides a more complete picture of the causes of impaired vision.

To gain estimates of the prevalence of low vision before its inclusion in surveys, the WHO in its *Global Update 1994* concluded that the number of people with low vision could be estimated using the ratio that there were three people with low vision for every person who was "blind."[3] The number in fact ranged from two to seven times the prevalence of blindness but three times was an average that could be used to derive an estimate.

An example that illustrates the magnitude of the total burden of vision impairment can be seen for Vietnam where the prevalence is very high for both low vision and blindness (Table 1). For every person who is blind there are 4.5 people with low vision. By way of comparison, in the Philippines the ratio is much lower with 1.5 people with low vision for each one who is blind.[4] Differences in the causes of vision impairment can account for the variation, as can differences in survey methodology.

The real needs for eye care programmes are not revealed when a country's average prevalence figures are used. The variation between parts of a country, particularly between urban and rural areas, does not reveal the existence of priority areas for intervention. In the Philippines the prevalence ranges from 8.86% in Western Mindanao, 7.4% in Metro Manila, to a low of 1.78% in the southern Tagalog Region.[4] Similar variation between regions was demonstrated in the Malaysian Eye Survey.[2]

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Table 1 Population, prevalence, and causes of vision impairment in the Pacific region countries

Country	Population (million)[6]	Rate of vision impairment (per million)*	Main causes of vision impairment	Source of data
Eastern Asia				
China	1284.48	17 000–23 400 37 000 lv	Cataract, retina, cornea Refractive error	S
DPR of Korea	24.03			
Japan	126.71	2300	Retina, optic atrophy, cornea	S
Mongolia[5]	2.66	10 400 70 700 lv	Cataract, glaucoma, CDK Refractive error	S
Republic of Korea	46.84	3000 12 000 lv	Cataract, AMD, glaucoma	E
South-eastern Asia				
Brunei Darussalam	0.32			
Cambodia	11.16	12 000 30 700 lv	Cataract, glaucoma, cornea	C/E/S
Lao PDR	5.43	20 500 lv	Cataract, cornea, glaucoma Refractive error	E
Malaysia	22.24	2900 20 400 lv	Cataract, retina, cornea Refractive error	S
Philippines[4]	75.96	7000 10 950 lv	Cataract, glaucoma, cornea Refractive error	S
Singapore[30]	3.56	4170	Retina, glaucoma, optic atrophy Refractive error	R
Vietnam	79.83	40 340 180 860 lv	Cataract, retina, glaucoma Refractive error	S
Oceania				
Australia[31]	18.88	2700 11 000 lv	AMD, cataract, glaucoma Refractive error	S
New Zealand	3.86	8600 lv		E
Melanesia				
Fiji	0.81	7000	Cataract, diabetic retinopathy	E
Papua New Guinea[32]	4.80	5000	Cataract, trachoma, trauma, glaucoma	S
Solomon Is	0.44	8000	Cataract, trauma, keratitis	C/E
Vanuatu	0.19			
Micronesia				
Kiribati	0.08			
Marshall Is	0.06			
Micronesia	0.11			
Nauru	0.01		Diabetic retinopathy, cataract	C
Palau	0.02			
Polynesia				
Cook Is[33]	0.02	16 220	AMD, diabetic retinopathy, cataract	S
Samoa	0.18			
Tonga[34]	0.09	5600 18 000 lv	Cataract, cornea, diabetic retinopathy	S
Tuvalu	0.01			

*The first figure given is for the rate of blindness and the rate of low vision is indicated on the second line with "lv" beside the figure.
CDK = climatic droplet keratopathy; AMD = age related macular degeneration.
Source of data: S = survey; E = estimate; C = hospital clinic; R = register.

Point estimates are given to quote the rate of vision impairment. Only some of the surveys, such as the recent one in Malaysia with 18 027 people examined, give confidence limits around the estimate, prevalence 0.29%, CL 1%–7%.[2]

In a very few cases were there data available for the prevalence of vision loss for the whole population of a country. Most surveys are done on adult populations with the age of 40 years as the commonly used lower age limit for inclusion so figures reflect the prevalence of vision impairment in adults. The survey in Mongolia yielded prevalence figures of 1.4% blindness and 7.7% low vision in adults over the age of 40 and also estimated there to be 0.6% blindness and 2.4% with low vision for the whole population.[5] The relatively high prevalence of low vision in adults has implications for eye care planning.

Causes of vision loss

For each country in the Western Pacific region, the three most common causes of vision loss are listed (Table 1). Where refractive error was also reported as a significant cause of correctable vision impairment this also is noted.

Cataract remains the leading cause of vision impairment in most countries in the Western Pacific region. This is similar to most of the world's economic regions—India, China, sub-Saharan Africa, Latin America and the Caribbean, the Middle Eastern crescent, and other Asia and islands. In countries included in the established market economy grouping, such as Japan and Australia, age related retinal disease is the most common cause of blindness. The transition from where cataract predominates as a major cause of vision loss to one where age related retinal disease accounts for most vision loss results from both high cataract surgery rates in these countries but also the ageing of the population. Japan has the oldest population of any country with males and females expecting to live on average for 75 or 82 years.[6]

Ho and Schwab demonstrated the relation between socioeconomic development and the prevalence of blindness, with those countries with lower gross domestic product (GDP) having higher rates of blindness.[7] This relation is evident in the Pacific region with countries with higher GDP (such as Japan, Korea, and Australia) having much lower rates of blindness than countries such as Cambodia, Laos, Vietnam, and rural areas of China (Table 1).

Socioeconomic development is also related to the important causes of vision impairment. Increasing socioeconomic status with improvements in water supply and hygiene practices has been associated with the progress in the elimination of vision impairment from trachoma.[8] However, in isolated areas or

islands, such as Papua New Guinea and Fiji, isolated "pockets" of trachoma exist today. Trachoma is also endemic among indigenous people living in rural and remote areas of Australia.[9]

The diabetes "epidemic" with vision loss from diabetic retinopathy has become an issue in both developed and developing countries. The small island nation of Nauru has one of the highest rates of diabetes in the world.[10] Diabetic retinopathy ranks among the leading causes of vision impairment in Pacific island nations and Singapore (Table 1).

Trauma is often a cause of monocular blindness but less commonly of binocular vision loss.[11] This can be quite different in areas where landmine injuries are common. In a hospital based survey in Cambodia, trauma was the fourth most common cause of blindness and was responsible for 4% of bilateral blindness.[12] Of those, most were males in the 15–35 year age group and 82% of the trauma related blindness was the result of landmine blasts. With an estimated 4–10 million landmines in Cambodia,[12] trauma is likely to remain a significant cause of blindness in Cambodia for some time to come.

One significant change in survey methods in recent years has been the measurement of "presenting" and best corrected visual acuity. The measurement of presenting acuity is of importance to understand functional vision for activities such as driving and work. Measuring and reporting the difference between presenting acuity and best corrected acuity estimates the extent of uncorrected or undercorrected refractive error. This has significant resource implications for eye care and prevention of blindness programmes.

Refractive error, particularly myopia, is a major issue in the Asian countries[13] and for Asian people throughout the region.[14–18] It is not only the current prevalence that is the concern but the upward trend in the prevalence. The Singapore Armed Forces has longitudinal data that show that a quarter of their recruits in the late 1970s were myopic and that the figure has risen to 83% in the late 1990s.[19] In Singapore the prevalence ranges from 20% of children at age 7 years to a prevalence exceeding 70% for students on completion of college education.[13] Myopia appears to have a younger age of onset over time.[20]

The rates of myopia are not the same in people of the same ethnic origin.[13] School children aged 6–7 years in rural southern China had a lower rate (3.9%) than children in Singapore (12.3%).[21]

Complications of high myopia contribute to the burden of vision loss and blindness.[22] Myopia that can be corrected and high myopia leading to complications contribute significantly to healthcare costs. In Singapore these have been calculated to be $90 million for spectacles, $3 million for refractive surgery, and the costs of management of complications such as retinal detachment and contact lens complications are $2.5 million.[13]

Vision loss and blindness in children

There is a paucity of data on the prevalence and causes of vision impairment in children in general and the Western Pacific region specifically. Given the low prevalence of vision impairment in children, population based studies are rarely conducted with data usually drawn from school or clinic based surveys. Results do not necessarily reflect the prevalence and range of causes of vision loss and blindness owing to policies for enrolment of students, under-representation of children from poorer communities, and non-inclusion of preschool age children.

There is a general trend for a greater proportion of childhood vision loss to be due to genetic causes with increasing economic and healthcare development.[23] In China almost one third of severe vision impairment and blindness is the result of genetic disease, most commonly retinal dystrophies, whereas this can account for up to half in industrialised countries.[24]

The WHO has mapped the prevalence of vitamin A deficiency in regions where data are available to indicate its importance for public health.[25] Countries listed in the Western Pacific region were the Philippines, Vietnam, and Papua New Guinea.

Trends

Japan has a long history of prevention of vision loss and blindness. Trends in the changing causes of eye health problems can be traced through school screening for children. Concern for the health of Japanese schoolchildren resulted in laws enacted during the 1881–1900 period.[26] Diseases then seen in schoolchildren were myopia, tuberculosis, rickets, headache, anaemia, and contagious diseases such as trachoma. The school health records have traced the prevalence of myopia in high school students from 1948 to 1996 with the prevalence increasing from 10% to almost 60%.[26] There has also been a decrease in the prevalence of xerophthalmia in Japanese children from the beginning to the middle of the 20th century without any conscious or direct effort to eradicate it.[25]

At the time of the passing of the Trachoma Prevention Act the prevalence of trachoma in Japan was recorded as 25%. With the inclusion of prevention and treatment of trachoma as one of the national health projects, the prevalence declined to less than 10% in the 1920s until the second world war when there was an increase to almost 20%. The Trachoma Prevention Act was repealed in 1983 with the disappearance of the disease.[26]

Japanese people now have the longest life expectancy of people in any country. The longevity has impacted on the presence and increasing prevalence of age related eye disease. The Japanese National Society for the Prevention of Blindness survey identified six major causes of acquired blindness, three of which were age related—glaucoma, cataract, and retinal pigment degeneration. Other causes, in order of prevalence, were diabetic retinopathy, high myopia, and optic nerve and retinochoroidal degeneration (Table 1). This current situation in Japan is similar to that in other industrialised countries in the Pacific region such as Australia, New Zealand, Republic of Korea, and Singapore (Table 1).

DEVELOPMENT OF EYE CARE PROGRAMMES

The launch of prevention of blindness programmes in the Western Pacific was at a WHO biregional workshop held in the Manila Regional Office in 1981. A recommendation from the meeting was that each member state develops a national plan using examples from the Asian region such as India.

As a result of the diversity in the region, there is no single model of blindness prevention for all. As part of The Global Initiative for the Prevention of Avoidable Blindness: Vision 2020, countries within the Pacific region meet regularly with IAPB officers to further develop their specific national prevention of blindness plans.

The evolution of eye care services and the stage of eye care delivery in any area can be explained by a series of pyramids (Fig 1). The delivery of eye care comprises four sequential stages. The stage in the evolution depends on each country's situation—the magnitude and nature of blindness, its national and external resources, and changing socioeconomic standards. Differences exist within countries where rural areas are at a lower stage of development than the better resourced urban areas.

The first stage is the planning stage where eye care, funding, and personnel come from foreign sources. Stage 2 is the primary healthcare (PHC) or primary eye care (PEC) stage where prevention of blindness (PBL) planning and activities commence. The third stage is characterised by the development of an eye healthcare system. At the final stage is the

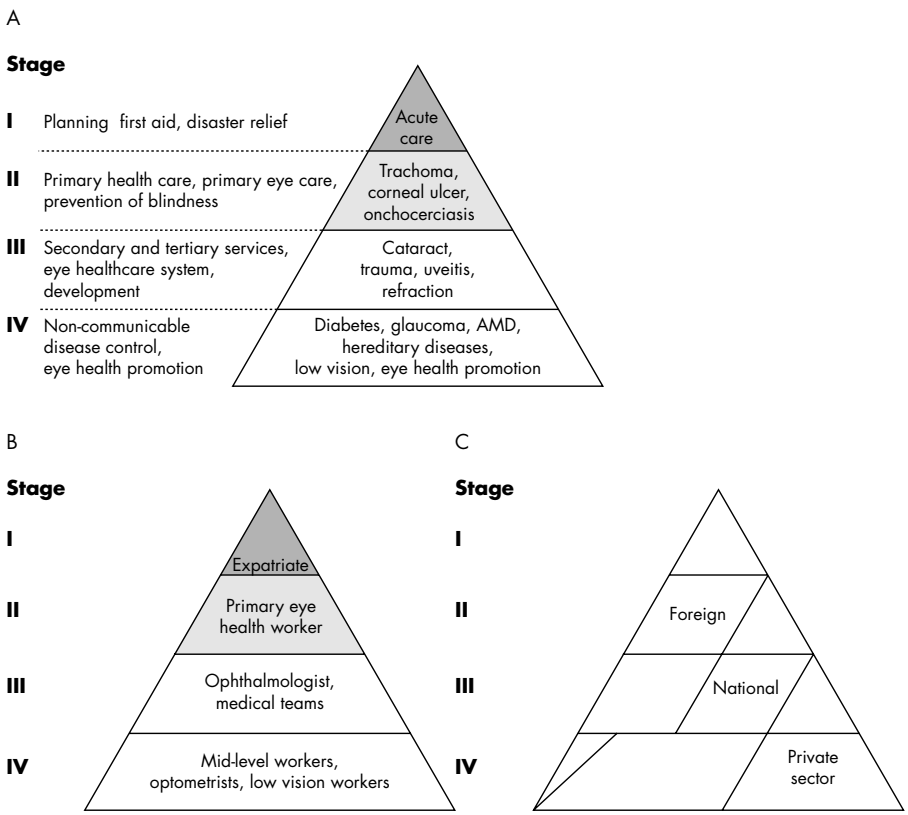

Figure 1 (A) Delivered eye care, (B) staffing, (C) funding.

transition to eye care programmes as part of the control of non-communicable diseases.

Stage 1—Planning stage

There are very few countries in the Pacific region at this stage (Fig 1A). Only acute interventions for serious and traumatic events are performed and only people with profound loss of vision, such as from cataract or serious threats to vision, receive treatment. The average blindness rate is typically in the range of 1.0%. At least half of the vision impairment results from infections, blinding malnutrition, and cataract. Eye care services are almost only performed by expatriates on visits to the countries concerned or when people receive care in another country. Almost all funding comes from foreign governments or non-government organisations (NGO).

Blindness prevention requires outreach services. Some island countries in the South Pacific, rural areas of Asian countries, and Aboriginal communities in Australia remain in this stage. Many islands and remote areas in the Philippines have underserved areas.

Before the general election held under UN supervision in 1999 Cambodia was at this stage. The country lacked an eye care system and external voluntary groups provided eye care. It is now a country in transition where the range of eye diseases is being recognised and services have been established for their management.

The only medical and surgical eye care to many Pacific nations, such as Tuvalu and Micronesian countries, is provided by teams visiting annually from Australia and New Zealand.[27]

Stage 2—Primary health care/primary eye care/prevention of blindness stage

Most countries in the region have developed a primary healthcare system based on the "Health For All" strategies.[28] This has provided an opportunity for the eye sector to integrate a community based and prevention oriented eye care model into community health programmes.

Cataract is the main cause of blindness, but corneal disease is also common. Corneal blindness follows infection, malnutrition, or neglect of possibly treatable conditions. Prevalence of blindness often is within the 0.5% to 1% range. Average per capita income is approximately US$ 1000.

An IAPB meeting in Sydney in 1992 identified human recource development as the highest priority to develop eye care in countries in the region. This involved training of ophthalmologists so that the target of one ophthalmologist for every 250 000 people could be achieved. Special attention is given to training ophthalmologists in programme management in addition to medical and surgical skills.

The need was also identified for "middle level eye care workers" who could be trained as assistants to ophthalmologists or as an ophthalmologist substitute for some functions. The possible roles identified for these middle level eye care workers were basic clinical and public health functions and equipment maintenance. This provides the beginning of an eye care team with networking an essential element (see Fig1B and Table 2). Participants selected from countries within the region attend Lions SightFirst sponsored training courses that are conducted annually at Korat in Thailand.

This stage of eye care development is found in rural and remote mainland areas or islands of many countries in this region such as China, Cambodia, Vietnam, parts of the Philippines, Papua New Guinea, Fiji, and the other Pacific islands. Currently in the hilly region in Laos eye care is delivered by mid-level personnel with a short period of training with supplementary professional care provided from the central level. In China during 1999–2000 the SightFirst China Action Project has supported in excess of 1.2 million cataract operations, the first time that the number of operations has exceeded the annual incidence of cataract.

The aim for cataract surgery is a minimum cataract surgery rate (CSR) of 1500—that is, 1500 operations per year per million people.

Funding for eye care comes from a combination of national government funds, usually for primary health and eye care, but

Table 2 Information needs to be obtained on the factors listed for needs analysis, planning, and monitoring of eye care programmes

Positive factor	Negative factor
Definition and indicator	**Definition and indicators**
Staffing The number of eye care professionals of different categories: • number of ophthalmologists • number of mid-level eye care personnel (given in 100 000 population)	Magnitude of blindness problem • overall blindness rate • major blinding conditions • age/sex adjusted blindness rate • the estimate of cataract backlog • the prevalence of blinding trachoma, malnutrition
General health status • present status of healthcare system • physician population ratio • population pyramid • number of beds • number of eye beds • utilisation • population growth • dependent population • population less than 15 years of age • elderly population • life expectancy • infant mortality • EPI coverage	Socioeconomic status (SES) • total national income • income per capita • economic growth rate • degree of industrialisation • proportion of farmers • literacy rate • social welfare system • health financing system
Organisation and administration • policy • situation of blindness prevention • administration • presence and activity of the national and local committee • working structure and efficiency	Barriers • natural barriers hampering the progress of the national programmes • population density • average distance to the first level of contact and facilities where cataract surgery is available Natural barriers: • cultural, behavioural • structural, organisational/administrative • technical
Fundamental prerequisites • governmental commitment • commitment to blindness prevention and eye health care • external commitment • commitment of international and NGOs, including domestic NGOs	
Factors associated with staffing It is of utmost importance that eye professionals are expected to participate in prevention activities, not only clinical experts. In addition, the managerial skills of eye professionals are also important. This could be measured by: A Clinical capacity (level of clinical standard) • subspecialisation • the rate of IOL usage B Managerial capacity (level of public training) • the number of blindness prevention workshops and training courses	

external assistance is required to support the work and training of ophthalmologists, for equipment and the operation of hospital or eye care centres. However, progress relies much on continuing economic development. Progress can be measured by an increase in the CSR and the gradual reduction of blindness rate.

Stage 3—Eye healthcare system development

The third stage is characterised by the extension of the eye care network to almost the whole country and upgrading the quality of eye care. For cataract surgery the emphasis is on quality outcomes and an increase of the CSR. Cataract surgery with intraocular lens (IOL) is the routine procedure. The full range of ophthalmic specialty areas is developed, at least at the tertiary level within the healthcare system. The average prevalence of blindness is less than 0.5%.

The ratio of fully trained ophthalmologists approximates one per 100 000 people. Mid-level eye care personnel with basic training are selected to receive advanced training in clinical care and public health with the possibility of specialisation in refraction, orthoptics, low vision and rehabilitation, minor surgery, and eye banking. The Western Pacific region has developed a standard curriculum to train middle level eye care workers. The first advanced course has been conducted at Korat.

Where trachoma and blinding malnutrition exist they are integrated into local health care. One of the roles of primary or community based eye care is the case finding for cataract services. The referral pathways need to be built into healthcare networks.

For those unable to afford eye care, a social welfare system in many countries provides subsidised health care. During the third stage of development there is an emerging private healthcare sector. Per capita income is usually around US$ 3000 which allows greater freedom of choice to either purchase health care directly or through health insurance. The presence of a private ophthalmic sector puts pressure on ophthalmologists who work solely in the government sector as most practitioners can work only in one sector.

External financing from government aid programmes or NGOs is relied upon for new initiatives like low vision care and rehabilitation. Eye care is funded from the combination of foreign, national, and private sources (Fig 1C).

Korea, China SAR (Hong Kong), and Singapore reached this stage in the early 1980s. They are now moving on to the last stage where the new challenges are from unavoidable blindness. Before transition to the next stage more ophthalmologists are needed to increase the CSR to over 1000 and to provide services across all subspecialties.

Malaysia, the coastal region of China, and the urban areas of the Philippines are in this stage in contrast with the rural areas, where there is less choice in eye care and greater difficulty in access to all levels in the eye care network.

Stage 4—Non-communicable disease control

At this stage the major causes of vision loss and blindness are hereditary such as glaucoma, age related (macular degeneration), or those with a combination of aetiology—lifestyle and genetic such as diabetic retinopathy (Fig 1A). The blindness rate is as low as 0.1–0.2% which could be further reduced with health promotion programmes. Eye care teams develop specialisation for eye care delivery and research.

Almost all funding comes from with the country from government or private sources (Fig 1C). There is some responsibility on the part of countries at this level to provide assistance to those countries developing eye care systems. The WHO Collaborating Centres for the Prevention of Blindness in this region (Japan, China, and Australia) are charged by WHO to play a part in prevention of blindness through:

- operational research to improve the effectiveness and efficiency of existing resources
- technical consultancy to agencies and national programmes
- training of eye care professionals
- evaluation of national programmes on request.[29]

The eye care sector has great potential to take a lead in national and international non-communicable disease control schemes. Well planned, public health, and clinical management programmes have been developed for the prevention of vision loss and blindness from diabetic retinopathy. These are an example for public health initiatives for other complications of diabetes. Programmes to prevent vision loss and initiation of low vision services to reduce the impact of unavoidable vision impairment are key contributors to national programmes on healthy ageing.

CONCLUSION

In conclusion, two decades of regional experience have convinced us that successful blindness prevention is not simply successful blindness intervention programmes. Blindness prevention is successful when the eye care system in a country is opened up and available for all and is of an acceptable standard in terms of quantity and technical skill of its human resources. Thus, successful blindness prevention occurs with the development of an eye care delivery system that initially aims to expand coverage with basic services and then builds up the quality and range of services.

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REFERENCES

1 **World Health Organization**. *International classification of impairment, disabilities, and handicaps*. Geneva: WHO, 1980.
2 **Zainal M**, Ismail SM, Ropilah AR, *et al*. Estimates from the National Eye Survey, 1996. Kuala Lumpur: Ministry of Health, Malaysia, 2000.
3 **Thylefors B**, Negrel A-D, Pararajasegaram R, *et al*. Global data on blindness. *Bull World Health Organ* 1995;**73**:115–21.
4 **Olivar-Santos E**. Second national survey of blindness, Philippines, 1995. *Philippine J Ophthalmol* 1995:2553–55.
5 **Baasanhu J**, Johnson GJ, Burendei G, *et al*. Prevalence and causes of blindness and visual impairment in Mongolia: a survey of populations aged 40 years and older. *Bull World Health Organ* 1994;**72**:771–6.
6 **United Nations**. *World population prospects: the 1998 revision*. United Nations publication, 2000: http://www.un.org/esa/population/wpp2000h.pdf
7 **Ho VH**, Schwab IR. Social economic development in the prevention of global blindness. *Br J Ophthalmol* 2001;**85**:653–7.
8 **West SK**, Munoz B, Mkocha H, *et al*. Progressions of active trachoma to scarring in a cohort of Tanzanian children. *Ophthalmic Epidemiol* 2001;**8**:137–44.
9 **Lansingh VC**, Weih LM, Keeffe JE, *et al*. Assessment of trachoma prevalence in a mobile population in Central Australia. *Ophthalmic Epidemiol* 2001;**8**:97–108.
10 **Heriot WJ**, Borger JP, Zimmet P, *et al*. Diabetic retinopathy in a natural population. *Aust J Ophthalmol* 1983;**11**:175–9.
11 **Negrel A-D**. An approach to the epidemiology of eye injuries. In: Johnson GJ, Minassian DC, Weale R, eds. *The epidemiology of eye disease*. London: Chapman and Hall Medical, 1998.
12 **Jackson H**, Foster A. Causes of blindness in northeast Cambodia. *Ophthalmic Epidemiol* 1997;**4**:27–32.
13 **Seet B**, Wong TY, Tan DTH, *et al*. Myopia in Singapore: taking a public health approach. *Br J Ophthalmol* 2001;**85**:521–6.
14 **Liou H-L**, McCarty CA, Jin CL, *et al*. Prevalence and predictors of undercorrected refractive errors in the Victorian population. *Am J Ophthalmol* 1999;**127**:590–6.
15 **Lin LLK**, Shih YF, Tsai CB *et al*. Epidemiologic study of ocular refraction among school children in Taiwan in 1995. *Optom Vis Sci* 1999;**76**:275–81.
16 **Goh WS**, Lam CS. Changes in refractive trends and optical components of Hong Kong Chinese aged 19–39 years. *Ophthalmic Physiol Opt* 1994;**14**:278–282.
17 **Zhao J**, Pan X, Sui R, *et al*. Refractive error study in children: results from Shunyi District, China. *Am J Ophthalmol* 2000;**129**:427–35.
18 **Hosaka A**. Population studies—myopia experience in Japan. *Acta Ophthalmol* 1988;**185(suppl)**:37–40.
19 **Chew SJ**, Chia SC, Lee KLH. The pattern of myopia in young Singaporean men. *Singapore Med J* 1988;**29**:201–11.
20 **Wensor MD**, McCarty CA, Taylor HR. Prevalence and risk factors of myopia in Victoria, Australia. *Arch Ophthalmol* 1999;**117**:568–663.
21 **Zhan MZ**, Saw SM, Hong RZ, *et al*. Refractive errors in Singapore and Xiamen, China—a comparative study in school children aged 6 to 7 years. *Optom Vis Sci* 2000;**77**:302–8.
22 **Van Newkirk MR**. The Hong Kong vision study: a pilot assessment of visual impairment in adults. *American Ophthalmological Society* 1997;**95**:715–49.
23 **Gilbert C**. Childhood blindness. In: Johnson GJ, Minassian DC, Weale R, eds. *The epidemiology of eye disease*. London: Chapman and Hall Medical, 1998.
24 **Hornby SJ**, Xiao Y, Gilbert CE, *et al*. Causes of childhood blindness in the Peoples' Republic of China: results from 1131 blind school students in 18 provinces. *Br J Ophthalmol* 1999;**83**:929–32.
25 **McLaren DS**. The epidemiology of vitamin A deficiency disorders. In: Johnson GJ, Minassian DC, Weale R, eds. *The epidemiology of eye disease*. London: Chapman and Hall Medical, 1998.
26 **Mishima S**. Vision care principles and the history of prevention of blindness in Japan. In: Mishima S, ed. *Hoya Vision Care, the First Asia Pacific International Conference, Tokyo*. April 1998.
27 **Theile DE**, Bennett RC. The Pacific Islands project; the first 3 years. *Aust NZ J Surg* 1998;**68**:792–8.
28 **World Health Organization/UNICEF**. *Alma-Ata 1978: primary health care*. Report of the International Conference on Primary Health Care, Alma-Ata, USSR, 6–12 September 1978. Geneva: WHO, 1978.
29 **World Health Organization**. *Global initiative for the elimination of avoidable blindness*. WHO/PBL/97.61, Geneva: WHO, 1997.
30 **Lim KH**. Registration of new blindness in Singapore for 1985–1995. *Singapore Med J* 1998;**39**:104–6.
31 **Weih LM**, Van Newkirk MR, McCarty CA, *et al*. Age-specific causes of bilateral visual impairment. *Arch Ophthalmol* 2000;**118**:264–9.
32 **Dethlefs R**. The trachoma status and blindness rates of selected areas of Papua New Guinea in 1979–80. *Aust J Ophthalmol* 1982;**10**:13–18.
33 **Heriot WJ**, Crock GW, Taylor R, *et al*. Ophthalmic findings among one thousand inhabitants of Rarotonga, Cook Islands. *Aust J Ophthalmol* 1983;**11**:81–94.
34 **Newland HS**, Woodward AJ, Taumoepeau LA, *et al*. Epidemiology of blindness and visual impairment in the kingdom of Tonga. *Br J Ophthalmol* 1994;**78**:344–8.