Trends in the Pattern of Blindness and Major Ocular Diseases in Singapore and Asia

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Abstract

This article details the changing trends in the major causes of blindness and visual impairment in Singapore over the past four decades. A comprehensive review of existing data from published and unpublished sources on ocular disease studies and surveys in Singapore was conducted. The rates of blindness and visual impairment from cataract, age-related macular degeneration, glaucoma, diabetic retinopathy and refractive errors, as well as other major diseases are described and compared with other Asian countries. Such epidemiological data on the blinding conditions in our population are vital in the understanding of trends in ocular diseases, as well as in prioritising current health services and preventive programmes.

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Introduction

Singapore's population has grown rapidly since 1965, the year in which it gained independence. The total population enumerated at its first census in 1970 was 2 074 507, compared to 3 103 500 in 1997.[1] In addition, with rapid modernisation, industrialisation and economic prosperity, Singapore has achieved the status of a Newly Industrialised Economy, along with improvement in the standard of living as well as health care. A changing pattern of blindness that reflects the population growth and socioeconomic development of Singapore can be seen.

With affluence and improved health services, preventable blindness is now nearly eradicated while non-avoidable blindness is becoming commonplace.[2] This is clearly demonstrated by the control of infectious blinding conditions, in particular that of trachoma, and the elimination of malnutrition (and vitamin A deficiency). Cataract is the single most prevalent cause of blindness in the world, accounting for up to 80% of mass blindness.[3] However, cataract is being dealt with effectively in Singapore. With increased life expectancies, non-preventable diseases such as age-related macular degeneration, glaucoma and diabetic retinopathy will become of increasing importance in our population, just as they have in the West.

In this article, we examine changing trends in the major causes of blindness and visual impairment in Singapore over the past four decades. We review existing data from published and unpublished sources, including a search on Medline on published articles related to ocular disease studies and surveys in Singapore and Asia. The pattern of blindness and visual impairment from cataract, age-related macular degeneration, glaucoma and diabetic retinopathy, as well as other major diseases are described. The major causes of blindness and visual impairment in other Asian countries will also be reviewed and compared. This information is useful in the understanding of trends in blinding ocular diseases in Singapore, how we compare with the rest of Asia, as well as in prioritising current health care research, services and preventive programmes.

Trends in Blindness and Visual Impairment

Blindness Registry Data

An easily available source of blindness data is from the national blind registry, maintained by the Singapore Association for the Blind. The criteria for blind registration in Singapore follows that of the World Health Organisation's definition and include one of the following: visual acuity in the better eye of 20/200 (6/60) or less, or visual acuity in the better eye of 20/80 (6/24) or less, with peripheral visual fields less than 20° around fixation. The registered blind are categorised into one of eleven broad groups (Fig. 1). Using these data, Lim[4,5] estimated that the prevalence of blindness in Singapore

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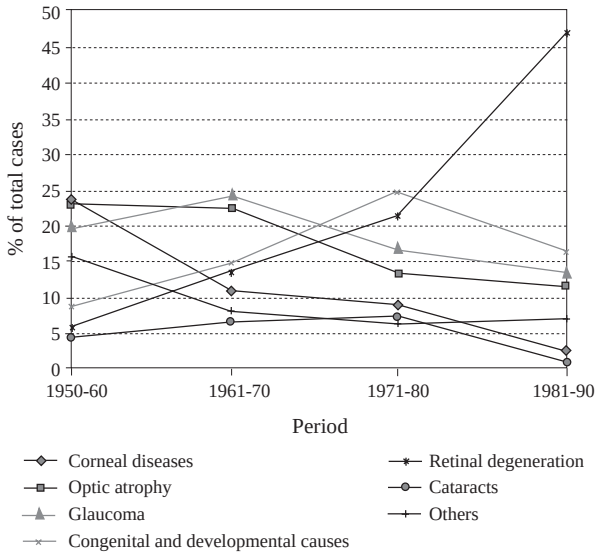

Fig. 1. Trends in the pattern of major ocular diseases in Singapore (Singapore Blind Registry data, 1950 to 1990).

appears to be one of the lowest in the world, at 55 per 100 000 population or 0.05%. This is likely to be a gross underestimation, compared to other data from developed countries and Asia (Table I[6-9]).

The impact of affluence on the major causes of blindness in Singapore over the last four decades, using registry data, was studied in 1990 by Low et al.[2] A total of 3182 patients registered blind were reviewed. The changing trend of the major blinding conditions can be seen in Figure 1. These figures show that from the 1950s to the 1960s, glaucoma overtook optic atrophy as the main cause of blindness, while corneal disease and uveitis took a sharp decline. In the 1970s, congenital blindness became the most prominent cause. Since the 1980s, however, retinal degeneration has become the main cause of blindness in Singapore. Yeo[10] emphasised this disturbing changing disease pattern in his article "National Report: The Prevention of Blindness in Singapore ".

A similar trend has also been observed in our neighbouring country, Malaysia. A recent study[11] that compared the prevalence and causes of visual impairment in 1994 and 1984, demonstrated an almost 50% decline in the prevalence of visual impairment in a rapidly affluent Malaysian population. While cataract remained as the main cause of visual impairment, diabetic retinopathy has emerged as the second most important cause, replacing refractive error and corneal diseases which were relatively more common in 1984.

The major limitation with the use of blind registry data is its incompleteness. Prevalence or incidence information can rarely be obtained from these registries. Cheong and Khoo (unpublished data) observed that there was a tendency to underreport blindness by a multiple of four. In general, as the registration is not compulsory, the database is not well maintained. In Singapore, only Singapore National Eye Centre (SNEC), Tan Tock Seng Hospital (TTSH) and National University Hospital (NUH) provide information to the registry; private practitioners do not register their patients.

Population-based Studies in Singapore

In Singapore, with an increase in life expectancy, it is projected that the over-55 population will increase significantly in the next 30 years. In 1990, the over-60 population comprised a tenth of the population, a total of about 250 000 people. This is projected to increase to 860 000 people in the year 2030. In a recent study of 3000 elderly people aged 60 and above, the prevalence of blindness and visual impairment amongst the elderly was 3.0% and 15.2%, respectively.[12] This can be contrasted with the blindness registration data which suggest that the prevalence of blindness in Singapore is only 0.05%.[5] In the United States, the Framingham Eye Study[6] estimated a prevalence of blindness of 0.6% in White population aged 50 and above, while in the United Kingdom and Australia, the prevalence is 0.2%[13] and 0.7%,[14] respectively. The population-based Baltimore Eye Survey,[9] conducted in east Baltimore, showed that the rates of total visual loss (<20 / 40) ranged from 0.74% among Whites 40 to 49 years of age, rising dramatically to 26.0% among Blacks 80 years and older. In other parts of Asia, the prevalence of blindness ranges from 0.4% to 1.2% (Table I).

Prevalence of Major Blinding Diseases in Singapore and Asia

The Singapore Blind Registry data suggest that retinal degeneration accounted for the biggest proportion of the registered blind in Singapore since the 1980s. This is further supported by data from 104 new cases seen at the Low Vision Clinic at the Singapore Association of the Visually Handicapped[15] from 1 April 1996 to 31 March 1997. Retinal degeneration accounted for nearly 50% of these cases (Table II). Again, the incompleteness of the data limits our ability to generalise the information.

In the study by Ho et al,[12] the prevalence of cataract, age-related macular degeneration, glaucoma and diabetic retinopathy for the population studied was 78.6%, 27.0%, 5.7% and 5.1%, respectively. The major causes of blindness can be compared to those in developed countries in the West and in Asia (Table I).

Cataract

Cataract is the single most important and common cause of blindness in the world.[16] One study estimates that this disease accounts for 50% of blindness worldwide.[17] In the study by Ho et al,[12] cataract was found in

TABLE I: PREVALENCE AND CAUSES OF BLINDNESS AND VISUAL IMPAIRMENT IN ASIA AND SELECTED DEVELOPED COUNTRIES IN THE WEST

	Developed countries			Asian countries					
Country	United States	United Kingdom	Australia	China	Japan	India	Pakistan	Indonesia	Thailand
Date of data	1973-75	1982	1996	1987	1980	1984-89	1990	1982	1983
Type of data	Survey	Registry	Survey	Survey	Registry	Survey	Survey	Survey	Survey
Definition of blindness (vision in the better eye)	<6/60	<3/60	<6/60	<3/60	<6/60	<3/60	<3/60	<3/60	<3/60
Population covered	Framingham, 2631 examined, 52 to 85 years old	Whole country, >16 years	Blue Mountains area, west of Sydney, Australia, 3647 examined, >49 years	29 provinces, 1 500 000	Blind population, rural versus urban	Whole country, 254 758 examined	Sindh province 6652 examined	Whole country	Whole country 19 265 examined
Prevalence of blindness (%)	0.6	0.2	0.7	0.4	NA	0.7	1.1	1.2	1.1
Main causes of blindness (%)	Cataract Glaucoma Diabetic (DM) retinopathy Age-related macular degeneration (ARMD)	ARMD 37 Glaucoma 13 Cataract 9 DM retinopathy 8 Refractive errors 5 Optic neuropathy 5	ARMD 87.5	Cataract 52 Refractive errors 14 Corneal opacity 7	Congenital 70 Intoxications 11 Systemic disease 4 Tumours 4 Trauma 3 Infections 2	Cataract 81 Refractive errors 7 Corneal disease 3 Glaucoma 2	Cataract 74 Corneal disease 12 Refractive errors 7 Glaucoma 3	Cataract 70 Corneal disease 5 Glaucoma 10 Refractive errors 4 Retinal disease 2 Nutritional disease 2	Cataract 57 Unknown 26 Refractive errors 4 Corneal disease 3 Glaucoma 2 Optic atrophy 2
Source of data	Leibowitz[6] (1980)	HMSO[13] (1982)	Attebo[14] (1996)	Zhang[8] (1992)	Thylefors[27] (1994)	MOH India[26] (1989)	Thylefors[27] (1994)	Thylefors (1994)	Thylefors (1994)

TABLE II: MAJOR CAUSES OF BLINDNESS SEEN AT THE LOW VISION CLINIC, SINGAPORE (1 APRIL 1996 TO 31 MARCH 1997)

Causes	No. of cases	% of total cases
Retinal degeneration	47	45.2
Congenital causes	14	13.5
Glaucoma	10	9.6
Optic atrophy	9	8.7
Others	24	23.1
Total	104	100.0

nearly 80% of the elderly population. This is similar to rates in other developing countries in Asia (Table I). Singapore has also seen a dramatic increase in the number of cataract extractions done each year. Despite the easy availability of cure, it appears that many elderly patients with cataracts are undiagnosed; the study by Ho et al found that for every person known to have cataract, 2 were previously undiagnosed. A combination of factors including poor self-awareness and poor knowledge of the disease, an unwillingness to seek medical attention and inability to do so all contribute to this public health problem.

Age-related Macular Degeneration (ARMD)

ARMD appears to be even more underdiagnosed although it was the second most common cause of blindness in Ho's study.[12] For every elderly person with known age-related macular degeneration, 154 were unknown. In line with increasing cataract surgeries, ARMD will be the leading cause of blindness in Singapore. In the United Kingdom, it accounts for nearly 40% of registered blindness.[13]

Retinal degeneration is now the leading cause of registered blindness in Singapore[2,15] due to an increase in the prevalence of both ARMD and diabetic retinopathy.

Glaucoma

Glaucoma is the third leading cause of blindness in the elderly in Singapore.[12] However, from registry data, in the 1960s, glaucoma was the most common cause of blindness in Singapore, accounting for 24.4% of blind registrations. This has dropped to 13.7% in the last decade (Fig. 1). There appears to be an excess of primary angle-closure glaucoma (PACG) over primary open angle glaucoma (POAG) in Singapore,[18] in a ratio of 4.5:1. This ratio probably reflects the asymptomatic nature of POAG and therefore underdiagnosis of this condition. A population-based survey of glaucoma prevalence is underway which will give more accurate data on this disease condition in Singapore.

For PACG, a recent island-wide survey[19] of the incidence of acute PACG in Singapore identified an array of risk factors, including age 60 or over (relative risk of 9), Chinese ethnic origin (relative risk of 2.8), and female gender (relative risk of 2.4).

Diabetic Retinopathy

Classified under retinal degeneration, diabetic retinopathy is a major contributing cause of blindness. Accounting for only 5.1% of blind registrations in the 1950s, retinal degeneration is now the most prevalent cause of blindness in Singapore, accounting for 47.3% in the 1980s. This may be in part due to an increasing prevalence of diabetes in Singapore. Population surveys in 1975,[20] 1985[21] and 1992[22] showed an increasing prevalence rate of diabetes of 1.99%, 4.7% and 8.6%, respectively of the Singapore population between the ages of 15 and 69 years. The importance of diabetic retinopathy as a leading cause of adult blindness in Singapore has long been recognised. In their article, Yeo et al[23] examined the various strategies and cost-effectiveness of implementing a nation-wide Diabetic Retinopathy Screening and Education Programme. Diabetic retinopathy screening was commenced in June 1991 by the Family Health Service, Primary Health Division, Ministry of Health, Singapore. Of a total of 13 296 patients screened or re-screened during a period of 25 months, 2911 patients (21.8%) were diagnosed to have diabetic retinopathy.[24] About half of these (10.8%) had sight-threatening retinopathy, i.e. pre-proliferative, proliferative or maculopathy. As the efficacy of laser photocoagulation is well-established in reducing blindness rates, diabetic eye screening plays an important role in the control of the morbidity caused by this disease. The Singapore experience has been that fundal photography offers a viable, inexpensive and reasonably reliable method for large-scale diabetic retinopathy screening.[25]

Corneal Diseases

The rate of blindness from corneal disease has been on a sharp decline, from being the most predominant cause at 23.6% in the 1950s to only 2.60% in the 1980s.[2] This is attributed to Singapore's improved socioeconomic status, improved nutrition and availability of eye care. In developing countries, corneal diseases are the leading cause of blindness after cataracts.[26,27] In addition, it appears that while dendritic corneal ulcers, keratoconus and corneal dystrophies account for the majority of blinding corneal diseases in other parts of the world, the pattern of cornea disease in Singapore differs somewhat, with a high proportion due to exposure and neurotrophic keratitis secondary to VII and V cranial nerve involvement from nasopharyngeal carcinoma.[28]

Infective keratitis remains a major ocular problem in Singapore. With an increasing population of contact lens wearers, contact lens wear has become the single most

predominant cause of bacterial keratitis, with *Pseudomonas* being responsible for 78.6% of contact lens ulcers, in place of dendritic and other infective ulcers that are still seen in many developing countries.[29] The spectrum of fungal keratitis also seems to be different from that in other developing countries in Asia. A review of fungal keratitis between 1991 to 1995 showed that the most common cultured organisms were *Fusarium* sp (52%) and *Aspergillus flavus* (17%).[30] It is interesting to note that whereas *Fusarium* species are the most important aetiological agents of fungal keratitis in the United States and Europe, in Asian series, the predominant organisms seem to be *Aspergillus* species.

The industrialisation of Singapore has led to an increase in the incidence of chemical corneal injuries as well as trauma-related keratitis. With an increased volume of ocular surgery, post-surgical bullous keratopathy has also been on the rise. Of the 327 corneal grafts performed at the Singapore National Eye Centre, post-cataract surgery bullous keratopathy was the indication in more than a quarter of all cases.[31] This is in contrast with a previous report on corneal transplantation in the eighties, which indicated that inflammatory corneal disease was the most common indication.[32]

Refractive Errors

Myopia is the most common eye condition in the world. In the United States, a report based on the National Health and Nutrition Examination Survey in 1971 estimated that 25% of the population between the ages of 12 and 54 years were myopic.[33] The Framingham Eye Study in 1973 to 1975 on an adult population between the ages of 55 and 85 years showed that the prevalence rate was 17%.[6]

In East Asia, the prevalence of myopia is significantly higher than in the West.[34] The disease also has an earlier onset. Moreover, the increase in myopia prevalence occurred rapidly over one generation. In Taiwan, a nation-wide refraction study covering 4000 children aged from 6 to 18 years showed a prevalence rate of over 75% at the age of 18.[35] In Singapore, several studies have indicated that the incidence and prevalence rates are amongst the highest in the world, with an estimated prevalence of 82% in medical students,[36] 63% in university freshmen[37] and 25% in 10-year-old Chinese school children.[38]

There is also concern that the prevalence and severity is increasing with time in Singapore.[39] The ocular morbidity associated with myopia is therefore of concern in Singapore and Asia. One of the more severe complications of myopia is retinal detachment. Between 1991 to 1996, Medisave data indicated that 1433 retinal detachment operations were performed in Singapore, giving an average incidence of retinal detachment as 8.8 per 100 000 population.[40] Over this period, there also appears to be a 25% increase in incidence of retinal detachment per year. It is informative that the annual incidence is highest for Chinese (average incidence of 9.4 per 100 000), followed by Malays (4.6 per 100 000) and lowest for Indians (3.1 per 100 000), reflecting perhaps the distribution of myopia in the population.

Ocular Trauma

Ocular trauma, in particular, penetrating eye injury, is an important cause of monocular blindness or visual impairment in the young and economically active age group. A study of 43 patients with open globe injuries seen at the Singapore National Eye Centre[41] in 1995 revealed that 71.4% of the open globe injuries were work-related, with 92% occurring in males with a mean age of 32.5 years. Other less common causes of ocular trauma include home accidents (7.9%), assault (7.9%), and road traffic accidents (6.3%). The majority of the patients who suffered work-related injuries did so while hammering or chiselling. As none of these patients wore protective glasses, nearly 71% of injuries may have been prevented. This emphasises the importance of providing appropriate safety glasses, educating workers on its use as well as enforcing its use. The immediate examination of the patient by a doctor is also important.

One of the major deficiencies of the present blindness classification system is that monocular blindness is excluded. There is a need to document monocular blinding conditions such as ocular trauma from industrial accidents, in order to monitor changing trends in this problem.

Retinopathy of Prematurity (ROP)

With one of the lowest infant mortality rates in the world, Singapore has seen an increasing number of premature babies surviving. The incidence of ROP may thus be expected to increase as well. A recent retrospective study[42] was done to investigate the incidence of ROP in Singapore over a one-year period. 34.4% of babies, with birthweights less than 1250 g or gestational ages less than 32 weeks, were found to develop ROP. The incidence correlated significantly with low birthweight, early gestational age, and multiple births. These results were comparable to previous studies done in England,[43] New Zealand,[44] and the US.[45]

Screening for ROP has been carried out in Singapore since 1987. Considering the results of the above study,[42] an optimal screening programme should include babies weighing less than 1250 g or of gestation earlier than 32 weeks. A first examination at 33 weeks of post-menstrual age has been suggested. With improvements in neonatal care, the incidence of ROP in Singapore remains low. Developing methods of avoiding premature delivery and extremely low birth weight will help in the prevention of ROP.

Conclusion

Epidemiological data on the major blinding conditions in Singapore are essential in our understanding of the changing trends in ocular diseases within the country, as well as compared to the other Asian countries. With Singapore becoming an increasingly affluent and urbanised country, preventable blindness (such as that secondary to cataract) is now in sharp decline while non-avoidable blindness is on the rise. Retinal degeneration, including age-related macular degeneration, diabetic retinopathy and myopic degeneration, has now become the major contributing cause of blindness. Glaucoma, especially primary angle-closure glaucoma, is also one of the leading causes of blindness in Singapore. In contrast, the rate of blindness from corneal disease has seen a large decrease due to urbanisation and improved nutrition and health care. The changing pattern of blindness and major ocular diseases therefore reflects the population growth as well as socioeconomic development of Singapore. A better understanding of the changing pattern of major ocular diseases is useful in helping us to prioritise our current health care services and preventive programmes. With improvements in neonatal care, national screening programmes for myopia in school children, diabetic retinopathy screening in the older age group, and stricter enforcement of protective eyewear for industrial workers, we should see a decrease in the prevalence of blindness in Singapore.

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