Review of key findings from the Singapore Malay Eye Study (SiMES-1)

Rosman M[1,2], FRCSE, FAMS, *Zheng Y*[2], MD, *Lamoureux E*[2,3], PhD, *Saw SM*[1,2,4], MBBS, PhD, *Aung T*[1,2,5], FRCSE, PhD, *Tay WT*[2], BSc, *Wang JJ*[3,6], MD, PhD, *Mitchell P*[6], MD, PhD, *Tai ES*[7], MD, PhD, *Wong TY*[1,2,3,5], FRCSE, PhD

INTRODUCTION This study highlights the key epidemiological findings from the Singapore Malay Eye Study (SiMES-1).
METHODS SiMES-1 was a cross-sectional, population-based epidemiological study on eye diseases. It was performed on 3,280 randomly selected Malay adults living in the south-western part of Singapore. All study participants underwent various validated questionnaires and detailed eye examinations. A review of all papers published from SiMES-1 was performed.
RESULTS A total of 24.6% of the study population had myopia, while 35.3% had hyperopia and 39.4% had astigmatism. 20.4% of the population had under-corrected refractive error. 1,338 (45.7%) participants were diagnosed to have cataracts in at least one eye. 8.6% of the study population had undergone cataract surgery in either eye, while 4.7% had bilateral cataract surgery. 150 (4.6%) participants were diagnosed to have glaucoma, of which primary open angle glaucoma was the most common type (3.2% of the study population), followed by secondary glaucoma (0.8%) and primary angle closure glaucoma (0.2%). Pterygium was diagnosed in 508 out of 3,266 study participants, giving a prevalence rate of 15.6%. The presence of diabetic retinopathy was observed in 421 (12.9%) out of 3,265 study participants. 183 (5.6%) study participants had some degree of age-related macular degeneration (AMD), of which 23 (0.7%) were classified as having late AMD.
CONCLUSION This paper provides a summary of the prevalence of common eye diseases among the Singaporean adult Malay population and provides data useful for public health education and disease prevention.

Keywords: eye diseases, prevalence, Singaporean Malays
Singapore Med J 2012; 53(2): 82–87

INTRODUCTION

The Malays are the indigenous people residing mainly in Malaysia, Singapore, Indonesia and other Southeast Asian countries. It is estimated that there are 200–300 million Malays in Southeast Asia. Based on the 2000 population census, Malays comprise 13.9% of the Singapore population.[1] Despite the large number of Malays in Southeast Asia, very few studies have been conducted on the prevalence of eye disease and visual impairment among Malays.[2-9] Thus, there is a lack of knowledge and awareness concerning the burden of eye disease and visual impairment within this population. The Singapore Malay Eye Study (SiMES-1), conducted between August 16, 2004 and July 10, 2006, was designed to address this gap in knowledge. The SiMES-1 provided important epidemiologic data on prevalence, risk factors and impact of eye diseases and visual impairment in adult Malay people. The findings obtained from this study have raised awareness on the common eye diseases affecting Malays, and thereby assisted in public health measures to reduce the burden of eye disease within this population. This paper is a review of the key findings of the SiMES-1 and aims to provide a summary of the prevalence and risk factors of common eye diseases among the Singaporean adult Malay population.

METHODS

The SiMES-1 was a population-based survey of 3,280 Malay adults aged 40–79 years living in Singapore, and was conducted from August 2004 to June 2006.[10-21] The methodology and recruitment methods for the SiMES-1 have been described in detail in a previous paper.[12] Briefly, the sampling frame consisted of all Malays aged 40–79 years living in designated study areas in south-western Singapore. From a list of 16,069 names provided by the Ministry of Home Affairs, an age-stratified random sampling method was used to select 5,600 names (1,400 people from each age decade of 40–49, 50–59, 60–69 and 70–79 years). The target sample size for this study was 3,150 persons. Of the 4,168 eligible individuals, 3,280 participated in the study (78.7% response rate).

The residential districts selected for this study were chosen due to the following potential advantages: (1) according to the 2000 Singapore Census,[1] the residents were a fair representation of the Singapore population in terms of age distribution, housing type and socioeconomic status; (2) there was a sufficient number of Malay individuals to obtain our study sample size; (3) the districts lay along the track of the Singapore subway train, which facilitated direct commute to the study clinic; and (4) the study area, which was approximately 110.4 sq km or 15.8% of the country's total land area of 699.4 sq km, covered a large sector of all populated areas in Singapore. Thus, based on the reasons stated, the study population should be representative of the Malay population in Singapore and the results of this study may be extrapolated for the entire Singaporean Malay population.

[1]Singapore National Eye Centre, Singapore, [2]Singapore Eye Research Institute, National University of Singapore, [3]Centre for Eye Research, University of Melbourne, Australia, [4]Department of Community, Occupational and Family Medicine, [5]Department of Ophthalmology, Yong Loo Lin School of Medicine, National University of Singapore, [6]Centre for Vision Research, University of Sydney, Australia, [7]Department of Medicine, Yong Loo Lin School of Medicine, National University of Singapore
Correspondence: Prof Wong Tien Yin, Professor & Director, Singapore Eye Research Institute, 11 Third Hospital Ave, #05-00, Singapore 168751. ophwty@nus.edu.sg

All study subjects underwent a clinic-based examination by trained optometrists and ophthalmologists. The examination included presenting and best corrected visual acuity assessments, refraction and a full ophthalmological assessment. A detailed interviewer-administered questionnaire was used to collect relevant sociodemographic and medical information (including educational level, marital status, occupation, housing type, income and presence of and details about any eye or systemic disease) by trained interviewers who were fluent in the Malay language. All subjects were instructed to bring their optical corrections, i.e. spectacles or contact lenses. During the evaluation in the clinic, all subjects were asked to put on their optical correction, even if they were not wearing them on arrival at the clinic. Individuals who had optical corrections but did not bring them to the clinic were categorised as non-spectacle or contact-lens wearers, as it was likely that they do not use optical corrections habitually since they did not bring it with them to the clinic.

Distance presenting visual acuity was monocularly measured using a logarithm of the minimum angle of resolution (LogMAR) number chart (Lighthouse International, New York, USA) at a distance of 4 m, with the participants wearing their 'walk-in' optical correction (spectacles or contact lenses), if any. A number chart was used for participants who were illiterate in the Latin alphabet. If no numbers were read at a distance of 4 m, the participant was moved to 3 m, 2 m and 1 m consecutively. If no numbers were identified on the chart, visual acuity was assessed as Counting Fingers, Hand Movements, Perception of Light or No Perception of Light. Refraction was determined by subjective refraction by trained and certified study optometrists. A trial frame was placed and adjusted on the participant's face. Autorefraction readings (Canon Auto Ref-Keratometer RK-5, Tokyo, Japan) were used as the starting point, and refinement of sphere, cylinder and axis was performed until the best visual acuity was obtained. Best-corrected visual acuity was monocularly assessed and recorded in LogMAR scores using the same test protocol as presenting visual acuity. Cycloplegic refraction was not performed.

The definitions of the various eye conditions described in this paper have been elaborated in various papers.[10-21] Age-related macular degeneration (AMD) lesions and progression of AMD were graded from fundus photographs using the Wisconsin AMD classification described in SiMES-1 and elsewhere.[14,22] Incidence, progression and regression of diabetic retinopathy were graded from fundus photographs using the modified Airlie House classification system and a modification of the Early Treatment Diabetic Retinopathy severity system for diabetic retinopathy.[20] The grading assessed the presence/severity of diabetic macular oedema and evidence of laser treatment.

Glaucoma was defined according to the International Society for Geographical and Epidemiologic Ophthalmology criteria.[23] Cataract severity was graded from slit-lamp and retroillumination photographs using the Wisconsin Cataract Grading System.[24] Refractive error was determined by subjective refraction. Myopia was defined as spherical equivalent (SE) refraction < −0.5 dioptres (D), astigmatism as cylinder < −0.5 D, hyperopia as SE > 0.5 D, and anisometropia as the difference in SE > 1.0 D.[18] Both the United States and revised World Health Organization definitions of visual impairment and blindness were used to define visual impairment and blindness.[21] Hypertension was defined as systolic blood pressure (BP) ≥ 140 mmHg, diastolic BP ≥ 90mmHg or physician diagnosis.[25] Diabetes mellitus was defined as HbA1c > 6.5%, casual glucose ≥ 11.1 mmol/L or use of diabetic medication.[20]

A PubMed literature search was performed for all years through October 2010 using the following search terms: *prevalence, Malays, eye diseases*. Relevant articles were retrieved and analysed. Cross-referencing was employed and reference lists from selected articles were used to identify additional pertinent articles. Population prevalence rates of eye disease were calculated by direct age and gender standardisation to the 2000 population census of Singapore Malays.[1] Proportions were compared using the chi-square test and means using the *t*-test, if parametric assumptions were fulfilled. Multiple logistic regression models were developed with the presence of eye disease as the dichotomous dependent variable and relevant predictors as covariates. All probabilities quoted were two-sided and considered to be statistically significant when < 0.05. Data was analysed using the Statistical Package for the Social Sciences for Windows version 15 (SPSS Inc, Chicago, Illinois, USA).

RESULTS

A total of 3,280 subjects were recruited for the SiMES-1. This represented a 78.7% response rate.[21] Of the 888 non-participants, 52.4% were female (compared to 52% in the participants of our study). The mean age of the subjects included in our study was 58 ± 11 years. However, the proportion of older people was higher among the non-participants (40–49 years: 17.3%; 50–59 years: 27.5%; 60–69 years: 26.2%; 70–79 years: 28.9%) compared to the participants (40–49 years: 24.8%; 50–59 years: 29.2%; 60–69 years: 23.8%; 70–79 years: 22.2%).[21] 55.1% of the non-participants were aged 50–79 years compared to 45.9% in the participant group, whereas 24.8% of the participants were aged 40–49 years compared to 17.3% in the non-participant group. The prevalence of the various eye diseases in our study population and the age-standardised prevalence in the Singaporean Malay adult population are summarised in Tables I and II.

Refractive error data were available from 2,974 study participants. 24.6% of the study population had myopia, while 35.3% had hyperopia and 39.4% had astigmatism. This gave an age-standardised prevalence rate of 26.2%, 27.4% and 33.3% in the Singaporean Malay adult population for myopia, hyperopia and astigmatism, respectively. Females and participants with higher education or cataracts were more likely to have myopia, while age was a significant risk factor for hyperopia and astigmatism. 20.4% of the study population had under-corrected

Table I. Summary of key SiMES-1 results (prevalence).

Disease	N	n	SiMES prevalence (95% CI)	Adjusted prevalence* (95% CI)	Age group (yrs)				p-value
					40–49	50–59	60–69	70–79	
Refractive error									
Myopia	2,974	731	24.6 (23.0–26.1)	26.2 (24.1–28.5)	31.0	19.7	16.4	33.6	0.739
Hyperopia	2,974	1,049	35.3 (33.6–37.0)	27.4 (25.6–29.3)	10.7	40.6	54.1	38.8	< 0.001
Astigmatism	2,974	1,173	39.4 (37.7–41.2)	33.3 (31.1–35.5)	23.2	33.3	47.7	63.2	< 0.001
Undercorrected refractive error	3,115	634	20.4 (18.9–21.8)	18.3 (16.7–20.0)	14.3	21.3	23.8	22.8	< 0.001
Cataracts (any)	2,927	1,338	45.7 (43.9–47.5)	29.9 (28.2–31.7)	6.2	28.5	69.8	93.7	< 0.001
Nuclear	2,896	665	23.0 (21.4–24.5)	12.9 (11.9–14.0)	0.1	4.2	30.5	74.2	< 0.001
Cortical	2,955	932	31.5 (29.9–33.2)	21.1 (19.7–22.6)	4.1	21.6	50.3	61.9	< 0.001
PSC	2,941	472	16.0 (14.7–17.4)	10.3 (9.3–11.4)	2.3	7.7	21.2	41.5	< 0.001
Cataract surgeries									
Any	3,280	283	8.6 (7.7– 9.6)	4.7 (4.1–5.4)	0.2	2.5	11.4	23.0	< 0.001
Bilateral	3,280	154	4.7 (4.0–5.4)	2.5 (2.1–3.0)	0.1	1.3	5.9	13.0	< 0.001
Glaucoma (any)	3,280	150	4.6 (3.9–5.3)	3.5 (2.8– 4.2)	2.2	2.9	5.1	8.8	< 0.001
POAG	3,280	104	3.2 (2.6–3.8)	2.5 (2.0–3.2)	1.7	2.9	5.1	8.8	< 0.001
PACG	3,280	8	0.2 (0.1–0.4)	0.1 (0.0–0.3)	0.0	0.1	0.1	0.8	0.002
Secondary	3,280	27	0.8 (0.5–1.1)	0.5 (0.3–0.9)	0.2	0.1	0.8	2.5	< 0.001
Pterygium (any)	3,266	508	15.6 (14.3–16.8)	12.3 (11.1–13.6)	7.1	15.0	19.0	22.0	< 0.001
Grade 1	3,256	166	5.1 (4.3–5.9)	4.0 (3.3–4.8)	2.5	3.6	7.1	7.9	< 0.001
Grade 2	3,256	240	7.4 (6.5–8.3)	5.9 (5.1–6.9)	3.5	8.2	7.8	10.2	< 0.001
Grade 3	3,256	92	2.8 (2.3–3.4)	2.2 (1.7–2.8)	1.0	3.2	3.8	3.5	0.002
Diabetic retinopathy (any)	3,265	421	12.9 (11.7–14.0)	11.1 (9.9–12.4)	7.5	13.2	18.6	12.5	< 0.001
Mild	3,265	52	1.6 (1.2–2.0)	1.4 (1.0–2.0)	1.0	1.5	2.7	1.2	0.272
Moderate	3,265	71	2.2 (1.7–2.7)	1.7 (1.3–2.2)	0.7	2.1	3.9	2.1	0.010
Severe	3,265	12	0.4 (0.2–0.6)	0.3 (0.2–0.7)	0.2	0.3	0.8	0.1	0.827
Proliferative	3,265	45	1.4 (1.0–1.8)	1.0 (0.7–1.5)	0.4	0.9	3.2	1.1	0.010
Macular oedema	3,265	46	1.4 (1.0–1.8)	1.1 (0.8–1.6)	0.5	1.2	3.1	1.0	0.054
Vision threatening	3,265	76	2.3 (1.8–2.9)	1.8 (1.4–2.4)	0.7	1.6	5.5	1.7	0.003
Age-related macular degeneration (any)	3,265	183	5.6 (4.8–6.4)	3.8 (3.2–4.6)	1.7	3.0	6.8	12.0	< 0.001
Early	3,265	160	4.9 (4.2–5.6)	3.5 (2.9–4.2)	1.7	2.8	6.4	9.6	< 0.001
Late	3,265	23	0.7 (0.4–1.0)	0.3 (0.2–0.6)	0.0	0.2	0.4	2.5	< 0.001
Retinal emboli	3,265	20	0.6 (0.3–0.9)	0.4 (0.2–0.8)	0.2	0.3	0.6	1.4	0.003
Retinal vein occlusion	3,265	22	0.7 (0.4–1.0)	0.5 (0.3–0.8)	0.1	0.5	1.2	1.0	0.014
Epiretinal membrane	3,265	384	11.8 (10.7–12.9)	7.9 (7.0–8.9)	2.3	7.3	19.0	20.4	< 0.001
Ocular trauma	3,280	149	4.5 (3.8–5.3)	5.0 (4.1–6.0)	5.7	5.3	2.7	4.3	0.033

*to population census (2000)
CI: confidence interval; PSC: posterior subcapsular cataract; POAG: primary open angle glaucoma; PACG: primary angle closure glaucoma

refractive error, and the age-standardised prevalence rate of under-corrected refractive error in the Singaporean Malay adult population was 18.3%. Older persons and those with lower educational levels had a higher risk of under-corrected refractive errors.

After excluding persons with cataract surgery and ungradable lens photos, data from 2,927 (89.2%) persons was available for analysis. The presence of any type of cataract in at least one eye was identified in 1,338 (45.7%) participants. When compared to participants without cataract, those with any cataract were older and had a higher prevalence of current smoking. Males were less likely to have cataracts. The age-standardised prevalence rate of any cataract in the Singaporean Malay adult population was 29.9%. 8.6% of the study population had had cataract surgery in either eye, while 4.7% had had bilateral cataract surgery.

150 (4.6%) study participants were diagnosed to have glaucoma. Primary open angle glaucoma was the most common type of glaucoma in the study population (3.2% of the study population), followed by secondary glaucoma (0.8%) and primary angle closure glaucoma (0.2%). In the multivariate analysis, the independent risk factors for glaucoma included increasing age, elevated intraocular pressure, low diastolic BP, low mean ocular perfusion,[26] longer axial length[27] and the presence of peripheral vascular disease, moderate-to-high myopia and retinal vascular narrowing.[28] Hypertension was associated with reduced odds of having glaucoma.

Pterygium was diagnosed in 508 out of 3,266 study participants (14 had missing data). This gives a prevalence rate of 15.6% in our study population (age-standarised rate of 12.3%). The presence of pterygium was more common among older

participants, males and those with high systolic BP. The presence of diabetic retinopathy was observed in 421 (12.9%) out of 3,265 study participants (15 participants either did not undergo retinal photography or had retinal photography of insufficient quality for grading). Proliferative diabetic retinopathy was observed in 1.4% of the study population, and 2.3% had vision threatening diabetic retinopathy. In the multivariate analysis, the independent risk factors for any diabetic retinopathy were longer duration of diabetes mellitus, higher HbA1C, hypertension and higher pulse pressure. Older age and higher total cholesterol levels were associated with reduced odds of any retinopathy. 183 (5.6%) study participants had some degree of AMD, of which 23 (0.7%) were classified as having late AMD. Males and those with lower educational levels had a higher risk of developing early AMD, while current smokers had a higher risk of developing late AMD.

The presence of retinal emboli, retinal vein occlusion and epiretinal membrane was evaluated in study subjects with gradable retinal photographs (n = 3,265). Of the 3,265 subjects, retinal emboli was observed in 20 (0.6%), retinal vein occlusion in 22 (0.7%) and epiretinal membranes in 384 (11.8%) subjects. The independent risk factors for retinal emboli were older age, cigarette smoking, elevated total cholesterol levels, elevated low-density lipoprotein cholesterol levels and a self-reported history of angina. Subjects with a history of heart attack or elevated total cholesterol levels had a higher risk of retinal vein occlusions. Older subjects, females and hyperopic subjects had a higher risk of developing epiretinal membranes.

A history of ocular trauma was reported by 149 (4.5%) of the 3,264 participants (data was missing for 16 participants). Of these, 30.2% (n = 45) had trauma from a blunt object, 33.6% (n = 50) from a sharp object and 22.1% (n = 33) were chemical burns. Men had a higher prevalence of ocular trauma than women. Younger persons were more likely to have ocular trauma than older persons. After adjusting for age and gender, alcohol consumption was also associated with a higher likelihood of having ocular injury.

Table II. Summary of key SiMES-1 results (risk factors).

Disease	Risk factors	OR; 95% CI
Refractive error		
Myopia	Female gender	1.87; 1.12–3.11
	Higher education	
	(High school vs. no formal)	1.61; 1.28–5.30
	(University vs. no formal)	2.79; 1.22–6.40
	Cataract	11.7; 2.90–47.90
Hyperopia	Age	1.07; 1.04–1.09
	Myopia	4.62; 3.19–6.69
Astigmatism	Age	1.08; 1.06–1.10
Undercorrected refractive error	Age	1.02; 1.01–1.03
	Female gender	1.22; 1.02–1.45
	Lower education (primary or lower vs. post secondary or higher)	1.89; 1.18–3.05
	History of eye disease	0.74; 0.60–0.90
Cataracts (any)	Age	6.62; 5.78–7.63
	Male gender	0.65; 0.52–0.82
	Current smoking	1.48; 1.10–1.99
Cataract surgeries	Age	2.70; 2.20–3.30
	Male gender	1.60; 1.00–2.50
	Diabetes mellitus	2.40; 1.80–3.10
Glaucoma (any)	Peripheral artery disease	2.55; 1.09–5.98
	Low diastolic BP (Q1 vs. Q4)	1.71; 1.04–2.96
	Low mean OPP (Q1 vs. Q4)	1.73; 1.05–3.15
	Hypertension	0.61; 0.38–0.97
Pterygium (any)	Age	1.30; 1.10–1.40
	Male gender	1.90; 1.50–2.60
	High systolic BP	1.60; 1.20–2.10
Diabetic retinopathy (any)	Age	0.73; 0.57–0.93
	Diabetes duration	1.07; 1.04–1.09
	Serum glucose	1.05; 1.02–1.09
	HbA1c	1.21; 1.10–1.33
	Systolic BP	1.17; 1.08–1.28
	Pulse pressure	1.34; 1.19–1.51
	Hypertension	1.85; 1.04–3.30
	Total cholesterol	0.75; 0.63–0.89
	LDL cholesterol	0.71; 0.58–0.87
Age-related macular degeneration (any)	Male gender	1.76; 1.15–2.70
	Educational level (primary or lower vs. secondary or higher)	2.20; 1.20–4.00
	Current smoking	3.79; 1.40–10.23
Retinal emboli	Age	3.52; 1.22–9.60
	Cigarette smoking	6.54; 1.78–23.98
	Elevated total cholesterol	5.67; 2.18–14.01
	LDL cholesterol	3.43; 1.36–8.67
	Self-reported history of angina	7.53; 2.07–27.47
Retinal vein occlusion	Heart attack	5.23; 1.79–15.30
	Total cholesterol	3.04; 1.24–7.43
Epiretinal membrane	Age	1.88; 1.66–2.13
	Female gender	1.66; 1.27–2.17
	Hyperopia (SE > +0.5 D)	1.68; 1.24–2.27
Ocular trauma	Male gender	4.70; 3.10–7.10
	Age	0.98; 0.96–0.99
	Alcohol intake	4.30; 2.20–8.40

OR: odds ratio; CI: confidence interval; Q: quartile; OPP: ocular perfusion pressure; BP: blood pressure; LDL: low-density lipoprotein; SE: spherical equivalent

DISCUSSION

Eye diseases are important causes of preventable visual impairment and blindness in the Singaporean adult Malay population.[21] Eye diseases among Singaporean adult Malays also result in significant morbidity and affect activities of daily living.[29,30] Our epidemiological study (SiMES-1) was able to provide epidemiological data on the common eye diseases affecting the Singaporean adult Malay population and their risk factors, which would be useful for public health education and disease prevention.

We compared the SiMES-1 results with those of an epidemiological eye disease study conducted by our centre on Malay adults aged ≥ 21 years from five villages and a provincial town in Indonesia (Table III).[2,3,5] The age-adjusted prevalence rate of participants with any type of cataracts was higher in our study compared to the Indonesian study (29.9% vs. 23.0%).[3] However, there was a significant proportion of participants in the Indonesian study who were below 40 years of age (54.6%), which should account for the lower incidence of cataracts.[3] The age-adjusted prevalence rate of myopia was similar in both

Table III. Prevalence of eye disease in rural Indonesia.

Eye disease	Age-adjusted prevalence (%); 95% CI	Definition	Age range (yrs)	Ethnicity	Total sample	Source
Cataract	23.0; 20.8–25.2	Either a LOCS III nuclear region score of ≥ 4.0, cortical ≥ 4.0, or PSC ≥ 2.0 in either eye	≥ 21	Malay	919	Husain et al[3]
Any nuclear cataract	17.7; 15.6–19.8	LOCS III nuclear region score of ≥ 4.0	≥ 21	Malay	919	Husain et al[3]
Any cortical cataract	16.3; 14.1–18.5	cortical ≥ 4.0	≥ 21	Malay	919	Husain et al[3]
Any PSC	7.9; 6.2–9.6	SC ≥ 2.0	≥ 21	Malay	919	Husain et al[3]
Myopia	26.1; 23.4–28.8	SE of at least −1D	≥ 21	Malay	1,043	Saw et al[5]
Hyperopia	9.2; 7.4–11.0	SE of at least +1D	≥ 21	Malay	1,043	Saw et al[5]
Astigmatism	18.5; 16.2–20.8	Cylinder of at least −1D	≥ 21	Malay	1,043	Saw et al[5]
Pterygium	10.0; 8.2–11.7	Any pterygium (clinician diagnosis)	≥ 21	Malay	1,210	Gazzard et al[2]

CI: confidence interval; LOCS III: Lens Opacities Classification System III; PSC: posterior subcapsular cataract; SC: subcapsular cataract; SE: spherical equivalent

studies.[5] However, the prevalence rates of hyperopia and astigmatism were higher in our study. This could be due to the difference in disease definitions: SiMES-1 defined hyperopia as SE > +0.5 D, while the Indonesian study defined hyperopia as SE of at least +1.0 D. SiMES-1 defined astigmatism as the presence of cylinder > −0.5 D in any eye, while the Indonesian study defined astigmatism as cylinder of at least −1.0 D.[5] The age-adjusted prevalence rate of any pterygium was also higher in our study (12.3% vs. 10.0% in the Indonesian study).[2]

Age was a significant risk factor for several of the common eye conditions and diseases among Singaporean adult Malays, including under-corrected refractive errors, cataracts, diabetic retinopathy, pterygium and retinal vascular diseases. Cardiovascular risk factors such as hypertension and elevated cholesterol levels were also associated with important sight-threatening conditions like diabetic retinopathy, glaucoma and retinal vascular diseases. Some of these conditions can be treated or prevented from progressing with early detection. Thus, it is advisable that all Singaporean adult Malays above the age of 40 years be encouraged to undergo regular eye screening by an eye care professional. This is especially so for those with additional cardiovascular risk factors.

It is postulated that there is a lack of knowledge and awareness regarding common eye diseases and sight-threatening conditions among the general Malay population. In a subset study on Singaporean adult Malays with under-corrected refractive errors, a large proportion did not know that they had refractive errors even though the poorer visual acuity from the under-corrected refractive errors were affecting their daily activities.[31] Over 20% of the study population did not even know what refractive errors are. However, the majority of subjects with under-corrected refractive errors indicated that they would visit an eye care professional if they knew they had refractive errors. Thus, nation-wide educational programmes to educate Singaporean Malay adults on common eye diseases and the need for regular eye screening would be useful in reducing the rate of eye diseases and improve compliance to regular eye screening among this population. Media campaigns, brochures, health talks incorporated into grassroots community-based activities and posters in clinics with appropriate educational messages about common eye diseases may increase the general level of knowledge in the Singapore Malay population.

Glaucoma and diabetic retinopathy are potential sight-threatening eye diseases and are important causes of visual impairment among Singaporean adult Malays.[21] In SiMES-1, more than 90% of subjects diagnosed with glaucoma were previously undetected.[19] 2.3% of all the study subjects were found to have vision-threatening diabetic retinopathy.[20] Both glaucoma and diabetic retinopathy can be treated and prevented from deteriorating if detected early. This highlights the need for health education and regular eye screening to reduce vision impairment among the Singaporean adult Malay population.

SiMES-1 had several strengths. We were able to assess the prevalence of eye diseases in a large sample of ethnic Malays in a population-based setting with a high response rate (78.7% response). We were also able to use our data to estimate the prevalence rates of the various eye diseases among the general Malay population, as our study, which involved a substantial landmass of Singapore (110.4 sq km of Singapore's total size of 699.4 sq km, estimated to be about 15.8%), included various types of residential areas and covered a large proportion of the populated areas in Singapore.

There were also several limitations in SiMES-1. The proportion of older people was higher among non-participants. Thus, it is likely that the actual prevalence rate of the various eye diseases in our study may have been underestimated. However, there were little differences with respect to gender, sampling location and telephone ownership between the two groups (data not shown). Another limitation was that the Malay population in our study was not representative of the majority of the Malay population in Southeast Asia, as Singaporean Malays are more highly urbanised compared to the large proportion of Malays in Southeast Asia who live in rural communities. Thus, we were not able to extrapolate our results to all Malays in Southeast Asia.

Despite these limitations, SiMES-1 may provide a reference for the prevalence rate of eye diseases among Malays in Southeast Asia. This is especially so for Malays living in large urbanised centres, for example, Kuala Lumpur in Malaysia, Jakarta and Medan in Indonesia. Similar epidemiological studies in these countries may reveal more information on the prevalence of eye diseases among Malays in Southeast Asia.

In conclusion, this paper provides a summary of the prevalence of common eye diseases among the Singaporean adult Malay population and provides data useful for public health education and disease prevention based on SiMES-1.

ACKNOWLEDGEMENTS

This study was supported by the National Medical Research Council Grants No. 0796/2003 and Biomedical Research Council Grant No 501/1/25-5.

REFERENCES

1. Leow B. Singapore Census of Population 2000: Statistical Release 1 - Demographic Characteristics. Singapore: Department of Statistics, 2001 [online]. Available at: www.singstat.gov.sg/pubn/popn/c2000sr1/t1-7.pdf. Accessed May 19, 2010.
2. Gazzard G, Saw SM, Farook M, et al. Pterygium in Indonesia: prevalence, severity and risk factors. Br J Ophthalmol 2002; 86:1341-6.
3. Husain R, Tong L, Fong A, et al. Prevalence of cataract in rural Indonesia. Ophthalmology 2005; 112:1255-62.
4. Lee AJ, Lee J, Saw SM, et al. Prevalence and risk factors associated with dry eye symptoms: a population based study in Indonesia. Br J Ophthalmol 2002; 86:1347-51.
5. Saw SM, Gazzard G, Koh D, et al. Prevalence rates of refractive errors in Sumatra, Indonesia. Invest Ophthalmol Vis Sci 2002; 43:3174-80.
6. Saw SM, Husain R, Gazzard GM, et al. Causes of low vision and blindness in rural Indonesia. Br J Ophthalmol 2003; 87:1075-8.
7. Zainal M, Ismail SM, Ropilah AR, et al. Prevalence of blindness and low vision in Malaysian population: results from the National Eye Survey 1996. Br J Ophthalmol 2002; 86:951-6.
8. Rosman M, Wong TY, Ong SG, Ang CL. Retinal detachment in Chinese, Malay and Indian residents in Singapore: a comparative study on risk factors, clinical presentation and surgical outcomes. Int Ophthalmol 2001; 24:101-6.
9. Wong TY, Foster P, Seah S, Chew P. Rates of hospital admissions for primary angle closure glaucoma among Chinese, Malays, and Indians in Singapore. Br J Ophthalmol 2000; 84:990-2.
10. Cajucom-Uy H, Tong L, Wong TY, Tay WT, Saw SM. The prevalence of and risk factors for pterygium in an urban Malay population: the Singapore Malay Eye Study (SiMES). Br J Ophthalmol 2009; 94:977-81.
11. Cheung N, Lim L, Wang JJ, et al. Prevalence and risk factors of retinal arteriolar emboli: the Singapore Malay Eye Study. Am J Ophthalmol 2008; 146:620-4.
12. Foong AW, Saw SM, Loo JL, et al. Rationale and methodology for a population-based study of eye diseases in Malay people: The Singapore Malay Eye Study (SiMES). Ophthalmic Epidemiol 2007; 14:25-35.
13. Kawasaki R, Wang JJ, Mitchell P, et al. Racial difference in the prevalence of epiretinal membrane between Caucasians and Asians. Br J Ophthalmol 2008; 92:1320-4.
14. Kawasaki R, Wang JJ, Aung T, et al. Prevalence of age-related macular degeneration in a Malay population: the Singapore Malay Eye Study. Ophthalmology 2008; 115:1735-41.
15. Lim LL, Cheung N, Wang JJ, et al. Prevalence and risk factors of retinal vein occlusion in an Asian population. Br J Ophthalmol 2008; 92:1316-9.
16. Loon SC, Tay WT, Saw SM, Wang JJ, Wong TY. Prevalence and risk factors of ocular trauma in an urban south-east Asian population: the Singapore Malay Eye Study. Clin Experiment Ophthalmol 2009; 37:362-7.
17. Rosman M, Wong TY, Tay WT, Tong L, Saw SM. Prevalence and risk factors of undercorrected refractive errors among Singaporean Malay adults: the Singapore Malay Eye Study. Invest Ophthalmol Vis Sci 2009; 50:3621-8.
18. Saw SM, Chan YH, Wong WL, et al. Prevalence and risk factors for refractive errors in the Singapore Malay Eye Survey. Ophthalmology 2008; 115:1713-9.
19. Shen SY, Wong TY, Foster PJ, et al. The prevalence and types of glaucoma in malay people: the Singapore Malay eye study. Invest Ophthalmol Vis Sci 2008; 49:3846-51.
20. Wong TY, Cheung N, Tay WT, et al. Prevalence and risk factors for diabetic retinopathy: the Singapore Malay Eye Study. Ophthalmology 2008; 115:1869-75.
21. Wong TY, Chong EW, Wong WL, et al. Prevalence and causes of low vision and blindness in an urban malay population: the Singapore Malay Eye Study. Arch Ophthalmol 2008; 126:1091-9.
22. Klein R, Klein BE, Tomany SC, Meuer SM, Huang GH. Ten-year incidence and progression of age-related maculopathy: The Beaver Dam eye study. Ophthalmology 2002; 109:1767-79.
23. Foster PJ, Buhrmann R, Quigley HA, Johnson GJ. The definition and classification of glaucoma in prevalence surveys. Br J Ophthalmol 2002; 86:238-42.
24. Lavanya R, Wong TY, Aung T, et al. Prevalence of cataract surgery and post-surgical visual outcomes in an urban Asian population: the Singapore Malay Eye Study. Br J Ophthalmol 2009; 93:299-304.
25. Sun C, Liew G, Wang JJ, et al. Retinal vascular caliber, blood pressure, and cardiovascular risk factors in an Asian population: the Singapore Malay Eye Study. Invest Ophthalmol Vis Sci 2008; 49:1784-90.
26. Zheng Y, Cheung N, Aung T, et al. Relationship of retinal vascular caliber with retinal nerve fiber layer thickness: the Singapore Malay Eye Study. Invest Ophthalmol Vis Sci 2009; 50:4091-6.
27. Perera SA, Wong TY, Tay WT, et al. Refractive error, axial dimensions, and primary open-angle glaucoma: the Singapore Malay Eye Study. Arch Ophthalmol 2010; 128:900-5.
28. Amerasinghe N, Aung T, Cheung N, et al. Evidence of retinal vascular narrowing in glaucomatous eyes in an Asian population. Invest Ophthalmol Vis Sci 2008; 49:5397-402.
29. Lamoureux EL, Chong EW, Thumboo J, et al. Vision impairment, ocular conditions, and vision-specific function: the Singapore Malay Eye Study. Ophthalmology 2008; 115:1973-81.
30. Lamoureux EL, Chong E, Wang JJ, et al. Visual impairment, causes of vision loss, and falls: the Singapore Malay Eye Study. Invest Ophthalmol Vis Sci 2008; 49:528-33.
31. Rosman M, Wong TY, Wong W, Wong ML, Saw SM. Knowledge and beliefs associated with refractive errors and undercorrection: the Singapore Malay Eye Study. Br J Ophthalmol 2009; 93:4-10.